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FLEXIBLE ALTERNATIVES TO HIGH CONCENTRATE FINISHING OF BEEF STEERS

BY

Kathryn Lorna Jacobsen

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of

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IN

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled *Flexible Alternatives to High Concentrate Finishing of Beef Steers* submitted by Kathryn Lorna Jacobsen in partial fulfillment of the requirements for the degree of *Master of Science* in *Animal Science.*

DEDICATED

To Mom and Dad

The work was mine,
but I am your achievement
and I thank you for the opportunity

ABSTRACT

Seventy-two British/Continental hybrid steers born in April/May, 1997 at the University of Alberta Ranch, were used to compare the relative production costs, performance and carcass characteristics of three wean-to-finish management systems. On October 2, 1997 the steers were randomly allocated to three treatment groups of 24 animals each. Twenty-four (F) animals were fed a balanced concentrate ration until finished (500 kg). The remaining 48 animals were backgrounded on brome hay until April 27, 1998 when 24 (BF) animals were put in drylot and fed to finish, while the other 24 (BPF) were grazed on mixed native/brome pasture. In early September animals were removed from pasture and fed to finish in drylot on a concentrate ration. Treatment did not have an effect on warm carcass weight or rib-eye area, however cutability, yield and quality grades were affected. When the market value of barley was above $124/tonne the inclusion of pasture within the wean to finish period resulted in an increased gross margin.

ACKNOWLEDGMENT

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CHAPTER ONE

General Introduction

1.1 History of the beef industry

Canadian beef production began with the importation of traditional British breeds (Angus, Hereford and Shorthorn) and dual purpose animals from France into Lower Canada during the mid 1500's (Sanders 1935). By the 1880's immigration into the West grew and colonization, accompanied by mixed farming, gradually spread westward. Cattle brought from the east combined with others moving north from the USA (mainly longhorns) to populate the main ranching regions of Southern Alberta and Southwestern Saskatchewan (MacEwan 1980). It was discovered that the early finishing British breeds did well on the prairie grass and could be finished in two to four years on grass alone (Nielson and Prociuk 1998).

A major shift occurred in the cattle industry during the 1940's and 1950's. A rapidly increasing population, coupled with higher per capita disposable incomes, increased the demand for beef after World War II. This demand was augmentation by the development of large retail grocery chain store corporations, which further stimulated the market for fed beef (Thompson and O'Mary 1983). The ensuing mass marketing of beef resulted in a shift in the type of beef required at the retail level. Consumers developed a preference for younger, leaner, more marbled beef, while retailers required a uniform product of reliable quality. These types of carcasses were difficult to obtain from cattle that had not been fed high concentrate diets in confinement (Thompson and O'Mary 1983).

Other factors in the agriculture sector also encouraged expansion of the cattle feeding industry. In the foothills of Alberta, many beef calves were being produced on large cow-calf ranches, which concentrated on calf production and not feeder finishing. The availability of large quantities of feed grains (particularly barley) in southern Alberta led to the development of feedlots in the area to feed these calves. Suitable climatic conditions (low precipitation and snowfall, relatively moderate temperatures) and easy access to both Canadian and United State markets made Southern Alberta a suitable feeding location (Nielson and Prociuk 1998).

Technological and organizational innovations relative to large-scale cattle feeding also made the development of large scale feeding a possibility. Entrepreneurs saw the situation as a viable method of adding value to grain in the form of fed beef.

As feedlots developed it became apparent that the early maturing biological characteristics of the British breeds were not as conducive to the feedlot system (Nielson and Prociuk 1998). British breeds had been successfully bred to finish early and fatten on grass and forage, and when these calves were placed on high concentrated diets at weaning they finished too early and at too light a weight. European cattle were found to be more suitable for the feedlot environment and the 1960's and 1970's saw the increase of continental cattle in Canada. European genetics (Charolais, Limousin and Simmental) which were initially restricted due to the prevalence of foot and mouth disease, were imported and introduced by pure-breeders and were eventually crossbred with the British breeds for hybrid vigor (Rouse 1973). Crossbreeding became a way to improve reproductive traits (calving rate, viability of offspring, offspring weaned per dam), increase growth related traits (weaning weights, carcass size) and satisfy consumer preference for leaner, marbled beef.

1.2 The current beef industry

There are three main phases within the current beef feeding industry: cow/calf production, backgrounding of feeder cattle and feedlot finishing (Karanumms et al. 1997). Calves are produced on a large number of relatively small (average 63 cows/farm) cow-calf farms (Statistics Canada 1996). They are usually born in the beginning of the year between January and May, nursed by their mothers over the summer months on pasture land and weaned in the autumn, between August and November, at approximately 200-250 kg live weight (Mathison 1993). Once weaned the calves either enter the feedlot immediately or pass through a backgrounding period where the calves are fed high forage diets to promote growth rather than fatness and to prepare the animal for the finishing stage (Karanumms et al. 1997). Animals are backgrounded for 100 to 150 days during the winter until the animals weigh between 350 and 500 kg. They are then grazed through the summer and

marketed as feeder cattle in the fall at approximately 18 months of age or alternatively fed to finish in feedlots (Mathison 1993).

Backgrounding refers to low input and extensive systems where cattle are grown for variable periods of time immediately after weaning on forage diets. It does not include systems where high quality forages are fed in the feedlot or where intensive grazing is used. Backgrounding may serve as a "holding" facility where feedlot operators house animals on a low rate of gain until they are needed to fill feedlot pens. In addition backgrounding may decrease overall feeding costs as gains made using forages are typically cheaper than gains on grain.

The feedlot industry is currently going though some structural changes. The industry is beginning to re-organize vertically with fewer owners and with strategic alliances developed between operators in each sector (McCaughey et al. 2000). Value based marketing is increasing by attempting to satisfy smaller, more specialized market segments. Backgrounding is also emerging as a larger sector of the cattle industry. Feedlots are purchasing backgrounded cattle because there is reduced sickness, decreased input time (because they are not weaning calves) and consistent weight gains already established (Sebastastian-Hanse 1995).

1.3 Problems facing the current beef industry

Food safety is the most important concern that the public has about beef (Van Donkersgoed 2000). The consumer has become conscious of the use of pharmaceuticals and hormones within the livestock industry and has become more aware of the food and health standards of the food they are consuming. In addition public concern related to the environmental impact of intensive farming operations on surface and groundwater resources, manure disposal, soil nutrient loading and odour is also increasing. Some protein sources are being questioned in the wake of food safety concerns such as the outbreak of *bovine spongiform encephalopathy* (BSE) in cattle ("mad cow disease") (Charmely et al. 2000).

It is quite possible that the traditional energy sources being used to finish animals (barley, corn) will become too expensive to feed to ruminants in large quantities. The reason for this may be due to direct competition with the rapidly

expanding human population (Charmley et al. 2000) and the subsequent decrease in arable lands for cereal production. In addition the resources available to the agricultural industry may be allocated to those livestock species which have a better relative efficiency of feed conversion (Cook 1977). Poultry use only 2.1 Mcal of digestible energy per kilogram live weight gain compared to 5.4 Mcal by beef (Cook 1977).

The Alberta beef feeding industry relies heavily on local feed barley sources and is therefore sensitive to fluctuations in barley price. The prospect of higher prices combined with increased volatility as barley is marketed on the world market in direct competition with other energy sources (corn) is a real possibility (Pearson, C. pers. comm.). World demand for grain as food will have a bearing on what grains farmers produce and hence on the kind, volume and cost of grain available for cattle feeding (Weisenburger 1981).

1.4 Objectives of research

Ruminants are unique in that they can derive a large proportion of their energy and protein requirements from feeds not suitable to monogastrics. This may become their greatest advantage in the agricultural sector as they can utilize materials unusable by humans (Charmley et al. 2000). Cattle have traditionally been used to graze forages grown on non-arable lands, rangelands and rough terrain areas, and it is only in recent history that cattle have been finished exclusively on concentrate diets. Pastures have been referred to as the "sleeping giant" of Alberta agriculture. The potential for land-based improvements in the beef industry is immense (Anderson 1985) using pasture management techniques (rotational grazing, appropriate stocking densities, and utilized appropriate cattle breeds) to increase pasture and animal productivity.

Sweeten et al. (1991) stated that beef production must continue to modify itself to the nutritional and palatability demands of consumers. In response to industry pressures it is imperative that alternative feed resources are examined for their feasibility and application to the industry. Among the advantages that beef production has over some of its competitive industries is its flexibility. There is no mandated

standard production system for beef cattle in Western Canada, making it easier for beef producers to make management changes in response to such things as availability and cost of feed ingredients, consumer preferences, and even public pressures of various descriptions. To maximize this advantage though beef producers need clear information on the biological and economic systems they are managing.

Forage finishing of cattle could be a viable alternative to the present and extensive use of grain to finish cattle (Grienbenow et al. 1997; McCaughey and Cliplef 1996). Forage finishing of beef cattle has been discouraged in the past (Smith 1990) due to deleterious effects on carcass and beef quality. Many of these findings are from studies in the 70's and 80's in which finishing of forage and grain fed beef was confounded with regard to backfat finish and days on feed (Mandell et al. 1997). Mandell et al. (1997) have shown that when the backfat levels at finish were controlled animals could be finished off pasture with similar levels of carcass quality and acceptability, especially after a short period of grain feeding (May et al. 1992; McCaughey and Cliplef 1996). Public perception is also increasing for cattle grazed on pastures especially as the health benefits of $\omega 3$ fatty acids in forage fed animals are becoming known (Mandell et al. 1998).

This study was designed to evaluate the economic viability of decreasing the dependency on barley by involving more forage within the wean to finish period. Treatment groups were either finished in the feedlot only, backgrounded and finished in the feedlot or backgrounded, grazed on pasture and then finished in the feedlot. The objectives of this study were:

1. to evaluate the potential for cattle to finish on pasture as an alternative to intensive feedlot finishing.
2. to evaluate the economic feasibly of incorporating increasing levels of forage within the wean to finish process.

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CHAPTER TWO

Animal Growth and Production

2.1 INTRODUCTION

Catch-up growth is used to describe the acceleration in growth (or extra growth) that occurs when a period of growth retardation ends and favourable conditions are restored. It is a self-correcting response which restores the individual to its original growth channel (Ashworth and Millward 1986). Usually it is considered in the context of recovery from nutritional deprivation, however other environmental stressors that affect animal growth, such as extreme temperatures, disease, plant toxins, or parasite infestation, could also be involved (Drouillard and Kuhl 1999).

One of the first agricultural references to the subject of catch-up growth was by Waters (1908) who studied the effects of undernutrition and refeeding in beef steers. During refeeding, he observed that the animals were able to recover and reached normal mature weights and heights. Bohman (1955) later coined the term compensatory growth to describe the accelerated and (or) more efficient growth that commonly follows a period of growth restriction. This term however may implies that the animal grew larger or bigger in order to compensate for the restriction which does not accurately describe the biological resumption of weight for age.

Many studies have been conducted to evaluate the factors involved with catch-up growth in a wide variety of species, including cattle (O'Donovan et al. 1984; Drennan 1979; Drennan and Harte 1979; Coleman and Evans 1986; Osoro and Wright 1991), poultry (Calvert et al. 1987), pigs (Pond and Mersmann 1990), sheep (Turgeon et al. 1986), rats (Harris and Widdowson 1978), and humans (Ashworth and Millward 1986; Desai and Hales 1997). And at least five major comprehensive reviews focused primarily on cattle and sheep have been published in the past forty years (Wilson and Osbourn 1960; Allden 1970; O'Donovan 1984; Berge 1991; Hogg 1991). In general, the current evidence clearly indicates that a period of feed restriction in mammals followed by a sufficient recovery period of unrestricted feeding, results in the same or better efficiency of feed utilization and growth than the continuously fed counterparts. In other words, an animal whose growth has been retarded exhibits, when the

restriction is removed, a rate of growth greater than that which is normal in animals of the same chronological age.

The biological phenomenon of catch-up growth is evident in the wild and probably represents a natural homeostatic response to cyclic changes in the availability and nutritive quality of feed (Wilson and Osbourn 1960). Fat-tailed sheep breeds grazing in arid regions accumulate fat in the tail during times of plentiful nutrition (spring and early summer) and then utilize these nutrients during the autumn and winter to sustain liveweight (O'Donovan 1984). This is very similar to the practise of allowing mature cows to utilize excess backfat during the winter rather than maintain unnecessary fat through expensive winter feeding (Boadi and Price 1996).

Inherent to beef management are cycles in the production, availability and cost of feed. By utilizing compensatory gains during the growth of an animal to mature size, periods of weight gains can be interrupted by times of reduced gains (or alternated within a "saw-tooth" pattern) to facilitate low-cost periods of slow growth followed by fast-growth during expensive feeding periods (O'Donovan 1984).

2.1.1   Factors influencing an animal's ability to recover from undernutrition

A comprehensive review conducted by Wilson and Osbourn (1960) identified six factors which influence an animals ability to recover from the effects of undernutrition.

1.   The nature of undernutrition

Retarded growth may result from the restriction of any component within the diet, however under practical feeding conditions it would most likely be protein and energy that would be in limited supply. It has been shown by numerous studies that recovery from protein and energy restriction is possible (Winchester et al. 1957; Fox 1972; Owen and Ochoa 1982; Abdalla et al. 1988; Drouillard 1991), however severe protein restriction may be harder to recover from than severe energy restriction. (Winchester et al. 1957; Denham 1977; Drouillard 1991). Blaxter (1956) pointed out that shortages of dietary energy are usually more important causes of low productivity

in livestock than are dietary deficiencies of vitamins, minerals and proteins due to management practises and the types of low cost feed (forages and pastures) involved.

2. The severity of undernutrition

This may best be measured by the animal's rate of gain, or loss in weight gain. Severe (weight loss), moderate (maintenance of weight) and mild (small weight gains) nutritional restrictions would fundamentally affect the degree of response of realimented animals. The more severe the restriction the greater the level of catch-up growth as long as development was not inhibited (Saubidet and Verde 1976; Wright et al. 1987). Beacom (1976) summarized the results of 13 experiments at Melfort, Saskatchewan and showed that for every 0.1 kg per day increase in rate of gain of calves in the winter there was a subsequent decrease of 0.07 kg per day in rate of gain of yearlings on pasture the following summer.

3. The duration of undernutrition

The duration of exposure to nutritional restrictions has an effect on an animals' ability for compensatory gains. Hogan (1929) showed that those animals retarded for the shortest periods exhibited the greatest weight gains after re-alimentation and eventually reached the highest mature weights. A long period of undernutrition combined with a severe level of undernutrition may be sufficient enough to eliminate any chance of subsequent recovery from the restriction.

4. The stage of development at the beginning of undernutrition

This is best measured by the weight of the animal at the beginning of undernutrition, rather than by its age. In general, the younger the animal when underfed, the less catch-up growth that can be expected. Winchester and Howe (1955) showed that when two animals were exposed to undernutrition equal in duration and severity, the heavier animal was able to recover more weight than did the younger animal. Yambayamba and Price (1991) concluded that restriction of six month old heifers for two to four months did not permanently affect heifer liveweight or body condition at slaughter.

5. Relative rate of maturity

Measured as the time taken to reach puberty or full maturity. Based on research by Joubert (1954) showing that the rate of maturation of different cattle breeds had an effect on the rate of recovery. Wilson and Osburn (1960) concluded that early maturing breeds would not be able to compensate as well as late maturing breeds. However, according to Preston and Willis (1974) the early maturing breeds would lose mainly carcass fat whereas the later maturing ones would lose more muscle and consequently take longer to recuperate. The literature is non-committal in this area however, as most of the research focuses on British breeds with no comparisons with the late-maturing, continental breeds such as Charolais and Limousine (Meadowcroft and Yule 1976).

6. The pattern of realimentation

The higher the level of nutrition supplied during realimentation, the greater and more rapid the recovery. Fox et al. (1972) showed that as the level of concentrate (dietary quality) increased in the diet, the degree of compensation also increased. High concentrate diets are not always required to experience compensatory gains though. Tudor et al. (1980) indicated that when equally restricted calves were realimented on either a high concentrate diet or grazed on pasture, those calves on pasture showed compensatory gains, while those on the concentrate diet did not (compared to their unrestricted controls on the equivalent recovery diet).

The numerous interactions of the many factors singly or together, make the determination of the degree of response difficult to ascertain. Many of the experiments being compared differ with regard to compensatory responses in terms of differences in the duration, timing, relative degree of severity and dietary nutrients used. However the general consensus is that following a period of undernutrition, catch-up growth in the form of increased gain for age, will occur.

2.1.2   Factors responsible for catch-up growth during realimentation

Realimentation refers to the repletion of animals, with attendant control groups, on adequate feed of acceptable quality, following a period of restriction (O'Donovan 1984). Numerous biological mechanisms have been proposed as being

responsible for the catch-up growth experienced during realimentation (Carstens et al. 1989). The physiological basis of each of these factors is by nature complex and the determination of their true influence is difficult.

Of all the factors considered to have a possible influence on compensatory liveweight gains, an increased appetite resulting in an increased food intake is generally thought to be the most important in the majority of circumstances (Lawrence and Fowler 1997). A greater voluntary feed intake is generally seen during realimentation of previously restricted animals, however this may not always occur in all cases. In cattle studies, intake has varied from a reduced consumption (Foot and Tulloh 1977; Murray 1980) to no change (Fox et al. 1972; Hironaka and Kozub 1973; Saubidet and Verde 1976) and a higher intake (Meyer et al. 1965; Park et al. 1987; Wright et al. 1986).

Differences in gastrointestinal contents ("gut fill") may also contribute to the evidence of compensatory gains. Ruminants are predisposed to large variations in gut fill (Stock et al. 1983); consequently live weight often not be an reliable indicator of empty body mass. Changes in gut fill may be inherent with some dietary regimes or management strategies and may thereby bias estimates of body weight and, hence, interpretation of animal performance. Lawrence and Pearce (1964) indicate that higher liveweight gains may be encountered in the earlier phases of realimentation due to a change in feed type as well as a change in the plane of nutrition, and that changes in gut fill significantly affected their calculations of live weight gain. Lawrence and Pearce (1964) suggested that gut fill adjustments probably exaggerated cattle gains (almost 2 kg daily) during the first month on pasture following restriction. Carstens et al. (1989) and Koong et al. (1983) also indicate that differences in gut fill weight were a contributing factor to catch-up growth, while Yambayamba et al. (1996) showed that gut fill did not contribute to compensatory weight gain.

Improved feed efficiency and nutrient utilization during realimentation are evident, particularly in the early stages (O'Donovan 1984). Saubidet and Verde (1976) ascribed increased gains to a lower maintenance requirement while Graham and Searle (1975) similarly showed that a lower basal metabolic rate coupled with a higher dry matter intake relative to maintenance was responsible for compensatory

gains. Increased efficiency of energy and protein utilization were also found to account for catch-up growth by Fox et al. (1972); Meyer and Clawson (1964) and Graham and Searle (1979).

Feeding cattle *ad libitum* on high energy diets following periods of restriction tends to promote rapid and efficient gains (Henrickson et al. 1965) and reduces the time needed to reach slaughter weight. However, there are indications that some degree of feed restriction may favour efficiency. Restricting feed to 80-90% of *ad libitum* intake promoted the most efficient gains when cattle were slaughtered at 500 kg (Drori et al. 1974).

Thomson et al. (1982) and Baker et al. (1985) have attributed changes in composition of tissue gained to catch-up growth. Meyer and Clawson (1964) observed that weight gain during catch-up contained more fat and less protein than did the gain of *ad libitum* fed rats and sheep. Wright and Russell (1991) however indicated that there is initially an increased proportion of protein and water in the empty body weight gain and a decreased in fat following realimentation. This is followed by a second phase during realimentation, in which there is an increase in fat deposition and a reduction in protein and water deposition, with the net result that the body composition reaches that of the unrestricted controls.

The extent to which each of these mechanisms contributes to catch-up growth remains unclear due to divergence in experimental design, the interdependency of these mechanisms and the fact that few experiments have been conducted to examine the mechanisms simultaneously.

2.1.3   Effect of catch-up growth on carcass traits and meat quality

Berg and Butterfield (1976) stated that in cattle the growth patterns of the tissues are such that bone grows at a steady but slow rate, and muscle grows relatively fast so that the ratio of muscle to bone increases. Fat comprises a relatively small amount of the carcass at birth but eventually its growth rate increases so that it approaches, and occasionally in very fat animals, surpasses muscle in absolute amount. The plane of nutrition experienced by the growing animal will have an effect on the relative development and presence of fat, bone and muscle within the carcass.

Of the three major tissues, bone is the least affected by plane of nutrition, followed by muscle and then fat (Callow 1961, McMeekan 1940). A high plane of nutrition therefore will promote earlier fattening while lower planes will delay the process .

When feed restriction occurs, the relative growth of bone, muscle and fat is altered under weight loss (Berg and Butterfield 1976). Fat is depleted the quickest and is followed by muscle and then bone with the degree dependant on the severity of the restriction. Under practical beef production circumstances the nutritional restriction of a very young animal and of growing animals to the point where they begin to lose weight would not be desirable (Drennan 1979). Therefore consideration of the effect of restriction to the point of fasting is not considered in this discussion.

Drennan (1979) concluded that while short periods of interrupted growth do not have any effect on carcass composition, restriction causing major delays in reaching the fixed slaughter weight, will result in a higher proportion of bone. Butterfield (1966) and Keenan et al. (1969) showed that realimented animals were leaner than those continuously grown. Fox et al. (1972) showed that cattle undergoing catch-up growth slaughtered at 364 kg with the controls were leaner but there was no difference in carcass composition when both groups were slaughtered at 454 kg. Generally after a moderate period of restriction, the carcass composition of restricted animals will not differ at slaughter as long as the animals have been given adequate time to recover from the restriction and are slaughtered at a comparable final weight. However if the restriction is more severe in duration and severity, differences in carcass composition, specifically fatness and bone, may occur.

Over the past twenty years numerous reports have examined the beef quality from cattle fed different amounts of grain and forage in feeding systems before slaughter. Forage-fed beef has been considered less flavourful than grain-fed beef (Hedrick et al. 1983; Buchanan-Smith and Mandell 1996), while in other studies forage-fed beef has been shown to have a similar or preferred flavour to grain-fed beef (Oltjen et al. 1971; Bidner et al. 1986; Buchanan-smith et al. 1991; McCaughey and Cliplef 1996). Buchanan-Smith and Mandell (1996) indicate that the major influence of forage-feeding on beef quality is with the flavour. It has been described by Larick et al. (1987) how grain-feeding before slaughter depletes the levels of flavour constituents

associated with grassy flavour within the meat. However the length of time that animals are grain fed before slaughter will affect the evaluation of the meat. While many of these studies have confounded differences in age and finish of forage and grain-fed beef at slaughter, the overall the lack of consensus in the literature would indicate that there may be very little difference in palatability between forage and grain fed beef if animals are youthful and slaughtered at a similar degree of finish (Buchanan-Smith and Mandell 1996).

In terms of other meat quality characteristics, the potential problem of yellow subcutaneous fat when forage-finishing beef animals has not been observed when feeding youthful animals (<2 yr old) a wide range of forage diets, including pasture (Buchanan-smith and Mandell 1994; McCaughey and Cliplef 1996). Buchanan-Smith and Mandell (1996) indicate that forage feeding should not have a general negative impact on tenderness unless the forage-fed animals are very old and the meat contains elevated amounts of connective tissue, which would arise in animals over two years of age. McCaughey and Cliplef (1996) showed no differences in texture, tenderness, juiciness, flavour and overall acceptability between pasture-raised steers fed grain for 0, 33 or 75 day before slaughter. Hawrysh et al. (1980) point out that for all practical purposes the eating quality of beef from steers finished on three levels of dietary roughage were acceptable, and that increasing the proportion of roughage in feedlot diets should not impair the eating quality of the resulting meat. Larick et al. (1987) concluded that minimal differences occur among forages with respect to their influence over sensory attributes of beef, providing that cattle are permitted sufficient time on high-concentrate diets. Therefore while finished animals may be slaughter directly off pasture or forage with little or no negative effects on the quality of meat, except perhaps for flavour, short-term concentrate feeding will remove any unfavourable factors that may be present.

2.1.4   Practical application of catch-up growth

Catch-up growth is of considerable practical significance to the beef industry (Drouillard and Kuhl 1999). By incorporating the biological benefits of compensatory gains into management strategies the producer can benefit by allowing its expression

to occur when input costs are greatest, thereby reducing the overall cost of production. Winchester et al. (1957) reported that the main disadvantage of restricting cattle (to promote compensatory gains later on) was to extend the time needed to reach slaughter weight. However compensatory gain can be used as a tool if the realimentation period coincides with low cost gains, such as that on pasture following a period of backgrounding (low level of feed restriction) during the winter (O'Donovan 1984). In order to increase profitability though, improvements in efficiency realized during the high-input phase must be sufficient to offset higher costs associated with decreased productivity during the low-input phase. (Drouillard and Kuhl 1999).

Feedlots commonly buy underfed steers, knowing they will compensate rapidly and efficiently (Yambayamba and Price 1991). Similarly culled cows and heifers can be fed grain and make very rapid, efficient and often profitable gains (Graham and Price 1982). Other applications of compensatory gains may occur during a temporary scarcity of food, such as when the spring is abnormally late and stored feed and pasture are limited. Feed can be daily rationed or else delivered less frequently to allow for short periods of retardation to be followed by *ad libitum* feeding and short periods of catch-up growth (Wilson and Osbourn 1960).

The current beef feeding industry relies heavily on cereal grains, namely barley, as the primarily source of energy for finishing cattle (Mathison 1993). The possibility of long term high feed grain prices in Western Canada (Novak and Viney 1995) makes it important to reassess alternate finishing strategies. The use of a pasture finishing system could be expected to increase production efficiency and reduce cost of production. Therefore the purpose of this study was to determine whether cattle could be finished on pasture under commercial beef production conditions, and if so how profitably.

2.2 MATERIALS AND METHODS

2.2.1 Animals and experimental design

Seventy-two British/Continental hybrid steers weighing 174.3 kg (SD ± 20.2) and 151 (SD ± 11) days of age at day one (October 2, 1997) were used in this experiment. They were born in April and May, 1997, weaned September 8, 1997 (SD ± 2.2) and castrated September 23, 1997. No growth promoting implants were used in this study. The steers were the second year result of a cross breeding program between the previously established beef and dairy synthetic herds (Berg et al. 1990) at the University of Alberta Ranch at Kinsella, 155 km south-east of Edmonton, Alberta.

Two breeding populations were established in 1960: the purebred Herefords (HE) and the Beef Synthetic (SY). In 1982, the HE line was merged into a crossbred Hereford line and was named Beef Synthetic #2 (SY2). The original Beef Synthetic line was then called Beef Synthetic #1 (SY1). The percentages of the contributing breeds in SY1 were approximately 33% each of Angus and Charolais, 20% Galloway, 5% Brown Swiss and a small amount of other breeds. The SY2 herd was approximately 60% hereford (Berg et al. 1990). In 1967 a Dairy Synthetic (SD) population was started and was composed of approximately 60% dairy breeds (Holstein, Brown Swiss) and 40% beef breeds primarily Angus, Hereford, Charolais and Galloway.

Ten days after castration (October 2, 1997) animals were allocated to one of three treatment groups (Figure 2.1) of 24 animals each. The first group, designated Feedlot (F) were allocated randomly to four pens of six animals each and gradually adjusted to a high concentrate diet (Table 2.1). The adjustment period continued until the animals had reached ad libitum intake of the concentrate ration only. They were then fed a balanced concentrate feedlot diet *ad libitum* (Table 2.1) until reaching market readiness. The second group designated Background/Feedlot (BF), were allocated to two groups of twelve and backgrounded through the winter on an energy restricted diet of brome hay (Table 2.1). Both backgrounding groups were supplemented with *ad libitum* oats during their first 29 days (October 2 to October 31) in the backgrounding pens. On April 27, 1998 they were

18

72 STEERS
born April/May 1997
weaned Sept 8 1997
castrated Sept 23 1997

Oct 2 1998

F
24 steers

BF
24 steers

BPF
24 steers

Feedlot
finished on high
concentrate diet
230 d

Backgrounded
on mixed
brome hay
207 d

Backgrounded
on mixed
brome hay
207 d

Slaughtered
May 20 1998
230 d

Feedlot
finished on high
concentrate diet
126 d

Pasture
grazed on mixed
native/brome
128 d

Slaughtered
Aug 30 1998
333 d

Feedlot
finished on high
concentrate diet
58 d

Slaughtered
Oct 30 1998
393 d

Figure 2.1 Schematic representation of the experimental design
F=finished in feedlot only; BF=backgrounded through winter and
finished in feedlot; BPF=backgrounded through winter, grazed
on pasture and finished in feedlot.

Table 2.1   Composition of the experimental diets (DM basis) fed to steers from October 2, 1997 to October 30, 1998

Ingredient	% ration (as fed)	% ration (DM)	DE^x Mcal kg^{-1}	CP^y %	$Phos^y$ %	Ca^y %
Feedlot diet						
Rolled Barley	63.3	56.88	2.073	6.12	0.287	57
Rolled Oats	21.2	18.98	0.634	2.08	0.063	23
Sun cured Alfalfa Pellets	10.5	9.20	0.240	1.14	0.021	38
Premix^z	5.0	4.45	0.177	0.24	0.080	27
Total	100.0	89.51	3.124	9.58	0.451	45
Backgrounding diet						
Brome Hay	100.0	91.41	2.217	8.20	0.232	21
Bedding						
Barley Straw	100.0	94.74	1.984	4.40	0.72	40

[x]DE=digestible energy=(88.9-(0.79*ADF %))/4.4

[y]CP=crude protein; Phos=phosphorus; Ca=calcium.

[z]Premix supplement composed of 72.2% canola meal, 12.9% limestone, 6.5% phosphorus (as biophos), 3.2% salt, 2.5% barley grain, 2.1% molasses and 0.65% vitamin A,D, and E

removed from the backgrounding pens and allocated at random to four feedlot pens of six animals each. They were adjusted to a feedlot ration over 23 days and then fed an *ad libitum* concentrate feedlot diet until reaching market readiness.

The third group Background/Pasture/Feedlot (BPF) were also randomly penned in two groups of twelve and backgrounded through the winter on a energy restricted brome hay diet. On April 27, 1998 the 24 animals were removed from their two backgrounding pens and placed as one group onto pasture. Three different native/brome pastures were utilized throughout the summer (Table 2.2). The first pasture was grazed for 56 days, the second for 28 days and the third for 44 days. On September 2, 1998 they were removed from pasture and allocated to four feedlot pens of six animals each. They were adjusted to a concentrate diet over 16 days and then fed an *ad libitum* concentrate feedlot diet in the same fashion as groups F and BF.

Market readiness was determined on the basis of liveweight. Animals were ready for slaughter when an average pen liveweight of 500 kg was reached. Prior to shipping, all animals were weighed and then held overnight with access to water, but not feed. Animals were trucked to the abattoir on the morning of slaughter as one group, weighed on arrival and slaughtered as soon as possible. All cattle were processed in the normal commercial manner. The F group were processed at Lakeside IBP Packers (Brooks, Alberta) while the BP and BPF groups were processed at the research abattoir in Lacombe (Agriculture and Agri-Food Canada Research Centre, Alberta). Both abattoirs were 250 km over similar roads, from the Kinsella Research Station. The research protocol for all cattle followed the guidelines established by the Canadian Council on Animal Care (1993).

2.2.2   Pasture samples and analysis

Pasture forage samples were collected each time animals entered or exited a pasture (Table 2.2). Available forage biomass yield of each pasture was collected at animal entry and exit. Biomass or standing crop refers to the weight of the plant organisms present at a particular point in time (Society for Range Management 1989). Four vegetation types (vegetypes) were identified within each pasture (tame grassland, native grassland, shrubland/forest, and lowland area surrounding salt water lakes) and the relative area of each determined (Irving, B. 1999: pers. comm.). Within each vegetation type, four areas (zones) were randomly selected and sampled four times using a 0.5 m^2 frame. A complete clipping of all available vegetation within the frame was carried out to a 3 cm height. Immediately following collection all individual forage pasture samples were dried at $65^{\circ}C$ for 48 hours in a forced-air oven, sorted for percentage of grass, forbs and shrubs, and weighed. The available biomass (dry matter basis) in each pasture was determined by multiplying the total weight of the dried material (grams) for each vegetation type by a factor of 20 to give dry matter in kg ha^{-1}.

Dried samples were ground through a 1 mm screen (Wiley mill, Standard model 3, Arthur H. Thomas Co., Philadelphia, Penn) and then analysed at the Alberta Agriculture, Food and Rural Development Soils and Crop Unit (6909-116 St, Edmonton, Alberta, T6H 4P9). Crude protein (CP), calcium (Ca) and phosphorus (P) were measured colorimetrically with a Technicon Auto Analyser II method in which samples had been prepared using the Kjeldahl digestion (method no. 7.002) according to standard procedures (Association of Official Analytical Chemists 1990). Acid detergent fibre (ADF), neutral detergent fibre (NDF) and ash were determined by the modified method of Goering and Van Soest (1970). Total digestible nutrients (TDN), digestible energy (DE), net energy for maintenance (NE_m) and net energy for gain (NE_g) were estimated from ADF. TDN = 88.9-(0.79 * ADF %); DE = TDN/4.4 ; NE_m = 0.077 Mcal/EBW$^{0.75}$; NE_G = (TDN % * 0.01318) – 0.459) (NRC 1996).

Table 2.2 Physical description of three pastures grazed from April 27 to September 3, 1998 at the Kinsella Ranch

Pasture	Area (ha)	Vegetation type	Description
1	36	tame grassland	smooth brome 20 yr+ old
	14	native grassland	rough fescue
	16	shrubland/forest	aspen groves
	1	lowland	
	<u>8</u>	salt water lake	
	75		
	15	tame grassland	smooth brome 20 yr+ old
	5	native grassland	rough fescue
2	3	shrubland/forest	aspen groves
	<u>17</u>	gravel	
	40		
	11	native grassland	rough fescue
	5	shrubland/forest	aspen groves
	2	lowland	
3	<u>8</u>	salt water lake	
	26		

Acid detergent fibre (ADF) and neutral detergent fiber (NDF) are both indicators of the amount of fiber within the plant. ADF contains cellulose and lignin, while NDF consists of cellulose, lignin and hemicellulose. NDF is related to the potential intake of forages whereas the ADF and lignin contents are indicators of forage digestibility. Lignin is a complex indigestible substance contained in the woody parts of plants and the fibrous portion of stems and leaves. Increases in lignin indicate a decrease in the amount of forage available to digestion and subsequently an overall lower level of digestibility (Perry and Cecava 1995). Digestible energy is the total energy of the diet minus the energy lost in the feces and reflects the digestibility of the diet. TDN is similar to DE but includes a correction for digestible protein. NE_m is the energy required to maintain the animal without promoting growth and is adjusted for the empty body weight of the animal. NE_g indicates the energy requirement necessary to gain at a certain rate (NRC 1996).

2.2.3   Feed, growth and carcass measurements

The concentrate diet was weighed and delivered each morning to animals in the feedlot pens. Animals in the backgrounding pens were fed as required every 2-4 days. Barley straw was used for bedding and was delivered to each feedlot and backgrounding pen as required. Supplementary salt, mineral and vitamins (Table 2.3) were available *ad libitum* to the animals during the backgrounding and pasture periods. The animals in the feedlot were provided mineral, vitamin and salt supplements within the feedlot diet (Table 2.1). Dates and amounts of feed, bedding and supplements delivered to the pens was recorded throughout the trial. All veterinary and medical expenses were also recorded including costs of medicine and the number of times treatments were administered per animal.

Daily dry matter intake for each animal during the feedlot and adjustment periods were calculated by dividing total feed (dry matter) delivered to the pen each day by the number of animals within that pen. Since the animals in the backgrounding pens were not fed every day, average intake between feedings was determined by dividing the dry matter delivered to each pen by the number of days since the last feeding. This average daily pen intake was then divided by the number of animals

Table 2.3 Composition of supplements provided to animals in the backgrounding pens and on pasture

Item	Contains	Amount present
Cobalt iodized salt block		
Salt (NaCl)	min	99.00 %
Iodine (I)	actual	180 mg/kg
Cobalt (Co)	actual	120 mg/kg
Trace Mineral block		
Calcium (Ca)	actual	15.00 %
Phosphorus (P)	actual	15.00 %
Magnesium (Mg)	actual	5.00 %
Potassium (K)	actual	0.07 %
Iron (Fe)	actual	1500 mg/kg
Cobalt (Co)	actual	100 mg/kg
Sulphur (S)	actual	0.013 %
Sodium (Na)	actual	0.011 %
Copper (Cu)	actual	7,000 mg/kg
Manganese (Mn)	actual	7,000 mg/kg
Zinc (Zn)	actual	10,000 mg/kg
Iodine	actual	0.002 mg/kg
Selenium	actual	50 mg/kg
Fluorine	max	2,000 mg/kg
Vitamin A	min	500,000 IU/kg
Vitamin D_3	min	50,000 IU/kg
Vitamin E	min	500 IU/kg

United Farmers of Alberta (Camrose)

within each pen to give an individual animal intake. Intake on pasture was not measured.

Weight, hip height and body condition scores were recorded for all animals to monitor their growth and were taken at the beginning and end of each feeding period and at 28 day intervals throughout the feeding period. Body condition scores are a very useful management tool in predicting body composition, in particular fat content (Wright and Russel 1984). Animals were removed from their pens and brought into holding pens where measurements were recorded. Weight was measured using cattle scales. Hip heights were measured using a tape measure as the greatest distance between the first sacral bone and the floor. Body condition scores were assigned using the technique developed by the East of Scotland College of Agriculture (Lowman et al. 1976) where a score of one indicates an emaciated animal and five shows a grossly fat individual (**see APPENDIX 1**).

Subcutaneous backfat thickness of the BF and BPF animals were measured on Backfat thickness was estimated ultrasonically using an Aloka 500V diagnostic real-time ultrasound with a 172 mm MHz linear array transducer using procedures described by Brethour (1992). Each animal was scanned at right angles to the spine (mid-line) over the *longisimus thoracis* muscle between the 12th and 13th ribs on the left side. The area to be scanned was soaked with mineral oil and then combed to reveal the skin. The generated image was then analysed for depth of fat by the technician.

Canadian Beef Grading Agency (CBGA) graders assessed the carcass data. Warm carcass weights were recorded on the day of slaughter, immediately after dressing, but before washing. Dressing percentage was calculated by dividing the warm carcass weight by the shrunk liveweight of the animal and expresses as a percentage (warm carcass wt/shrunk livewt *100) (Agriculture Marketing Manual 1999). After slaughter, carcasses were chilled at 4°C for 24 hours before being knife-ribbed between the 12th and 13th ribs for appraisal of carcass characteristics. Grade fat was the minimum thickness of fat in the fourth quadrant of the *l. thoracis* muscle between the 12th and 13th ribs. Marbling score was evaluated on a scale from 1.0 to 11.0 where 1.0 to 3.9 equals trace marbling or less (Canada A quality grade),

4.0 to 4.9 equals slight marbling (Canada AA quality grade), 5.0 to 7.9 equals small to moderate marbling (Canada AAA quality grade) and 8.0 to 11.0 equals slightly abundant or more marbling (Canada Prime). Cutability estimates (expected yield of trimmed, defatted lean from the major wholesale cuts in the carcass) were calculated as: % cutability = 57.96 – (0.027 * warm carcass weight, kg) – (0.703 * average backfat thickness, mm) + (0.202 * rib-eye area, cm^2) (Anonymous 1996). An imprint of the *l. thoracis* area was obtained using filter paper (Grade 601; 46 cm x 57 cm; Life Science Products, Inc., 10650 Irma Drive, Unit 26, P.O. box 33090, Denver, Colorado 80233). This 100% cotton paper was approved by Agriculture and Agri-Food Canada as "generally regarded as safe" for food contact. The *l. thoracis* area on each imprint was subsequently traced with a black felt pen. The area of the resulting polygon was then determined using an image analysis system (Kontron Bildanalyse Image Analysis System, release 1.3, Breslauer Strasse 2, 8057 Eching, West Germany) (Basarab et al. 1999).

2.2.4   Canadian beef carcass grading system

The purpose of carcass grading is to allocate carcasses into uniform groups to facilitate marketing (Anonymous 1996). The Canadian grading system categories beef carcasses on their marbling and lean meat yield after they have met age, fat, conformation and color requirements (**see APPENDIX 2**). Quality carcasses are ranked from Canada A, Canada AA, Canada AAA to Canada Prime depending on their marbling. Youthful carcass not making the A grade are place in the B grades. Canada B1 for insufficient fat or marbling; Canada B2 for yellow fat; Canada B3 for insufficient muscling and Canada B4 for dark cutters. Canada D grades are for mature cows, and Canada E for carcasses showing "excessive masculinity". The carcasses falling into the Canada A, AA, AAA, Prime categories are also assessed for meat yield. This is estimated from subcutaneous fat thickness and the area of the loin muscle at the 12th 13th rib interface. Carcasses are assigned yield grades as follows: Y1 for an estimated yield of 59 per cent or greater; Y2 for a 54-58 per cent yield; and Y3 for a 53 per cent or less yield. The value of slaughter cattle is ultimately

determined by the quality grade (Canada A, AA, AAA, B1 etc.) and the expected yield of lean meat (Y1, Y2 and Y3) (**see CHAPTER THREE**).

2.2.5 Statistical analysis

All available data (n=72) were used to determine the effect of treatment group (F, BF and BPF) on growth, performance and carcass characteristics. Individual animal live weights were regressed on days within each feeding period (background, pasture, adjustment, feedlot) and then tested for quadratic effects. Initial weight, average daily gain (ADG) and final weight for each feeding period were calculated from the individual regressions of liveweight on time for each animal. Liveweight, liveweight change, body condition score, hip height, intake and feed to gain ratios for each animal were subjected to least squares analysis of variance using the General Linear Model (GLM) procedure of the Statistical Analysis System Inc. (SAS Institute Inc. 1999). The covariate of initial weight of calf was tested and shown to be significant and therefore was included in the model. The following model was used:

$$Y_{ijk} = \mu + T_i + P_{j(i)} + \beta(x_{ij} - \bar{x}..) + e_{ijk}$$

where Y_{ij} is the trait under consideration, μ is the overall mean, T_i is the effect of the ith treatment group, and $P_{j(i)}$ is the effect of pen within treatment nested, $\beta(x_{ij} - \bar{x}..)$ is the initial calf weight (covariate) and e_{ijk} is the random error term. The error term for testing treatment group was pen nested within treatment.

A Chi square analysis (SAS Institute Inc. 1999) was used to compare yield grade and quality grade data between treatment groups.

The analysis of the remaining carcass data used the same model as above except with no pen effect leaving treatment group as the only source of variation and a random error term. The model was:

$$Y_{ij} = \mu + T_i + \beta(x_{ij} - \bar{x}..) + e_{ij}$$

where Y_{ij} is the carcass trait under consideration, μ is the overall mean, T_i is the effect of the ith treatment group, $\beta(x_{ij} - \bar{x}..)$ is the initial calf weight and e_{ij} is the random

error term. Pasture quality was subjected to least squares analysis of variance using the following model:

$$Y_{ij} = \mu + V_i + P_{j(i)} + e_{ij}$$

where Y_{ij} is the value under consideration, μ is the overall mean, V_i is the effect of the ith vegetype, P_j is the effect of pasture nested within vegetype and e_{ij} is the random error term.

2.3 Results and Discussion

2.3.1 Climate and Vegetation

The average precipitation (Table 2.4) is 43 cm per year with approximately 25% falling as snow in the winter and the remainder falling as rain mainly in June and July (Environment Canada 1990). Summer minimums average 8°C and maximums average 23°C with June and July being the warmest months. Prevailing winds are from the west and northwest (Wyatt et al. 1944).

The vegetation in the study area is typical aspen parkland pasture as described by Moss (1955). The dominant species in the forest are aspen groves (*Populus tremuloides*) in the over story with a mixture of shrubs in the understory: western snowberry (*Symphoricarpos occidentalis*), saskatoon (*Amelanchier alnifolia*), choke cherry (*Prunus virginiana*) and pin cherry *(Prunus pensylvanica)* (Moss 1955). The Kinsella Ranch grazing pastures contained a mixture of tame and native grasslands, with the major native grassland community being the parkland rough fescue (*Festuca scabrella*) association (Moss and Campbell 1947) and the tame grassland being smooth brome (*Bromus inermis*). Forbes are herbaceous broad leaved plants (dicots) and are abundant within the grazing pastures. The main species present are aster (*Aster spp.),* northern bedstraw (*Galium boreale.*), crocus (*Anemone patens*), fleabanes (*Erigeron spp.*), pea vine (*Lathyrus spp.*), pussy toes (*Antennaria spp.*), rushes (*Juncus spp.*), sage (*Artemisia spp.*), sedges (*Carex spp.*), violets (*Viola adunca*) vetch *(Vicia spp.*), and yarrow (*Achillea lanulosa*) (Moss and Campbell 1947).

The year of this study saw a significant reduction in precipitation (Table 2.4) during the growing season (April-September), receiving only 19 cm compared to the average of 32 cm. Average daily temperatures during the 1998 grazing period (Table 2.4) were also higher than the Canadian Normals for the last 40 years (Environment Canada 1998). The lack of moisture and higher daily temperatures resulted in a dryer pasture environment.

Table 2.4 Canadian climate normals (1961-1990) and annual temperature and precipitation (1998) for the Kinsella Ranch

	Daily Max (°C)	Daily Min (°C)	Daily Mean (°C)	Rainfall (mm)	Snowfall (cm)	Precipitation (mm)	Daily Mean (°C) 1998	Precipitation (mm) 1998
Jan	-10	-20	-15	0.6	20.8	21.5	-18	36
Feb	-6	-16	-11	0	13.5	13.6	-6	3
Mar	-1	-10	-5	0.8	19.6	20.4	-5	7
Apr	10	-2	4	8.7	12.2	20.9	8	9
May	17	4	11	39.6	1.3	41.0	14	16
Jun	21	9	15	83.9	0	83.9	15	74
Jul	23	11	17	75.7	0	75.7	19	26
Aug	22	9	16	59.9	0	59.9	19	24
Sep	16	4	10	36.7	0.9	37.6	13	39
Oct	10	-1	5	10.3	5.6	16.2	6	32
Nov	-2	-10	-6	1.9	15.0	16.8	-5	16
Dec	-8	-17	-12	0.9	20.0	20.9	-12	15
Year	8	-3	2	319.3	108.9	428.5	4	299

Kinsella=53°00-N 111°31-W/O, 705 m, Environment Canada

[x] Snowfall precipitation calculated by dividing snowfall (cm) by 10

2.3.2   Pasture quantity

Available plant dry matter biomass present between April 27, 1998 and September 3, 1998 is shown in Table 2.5 and Figure 2.2. Grazing patterns and forage utilization of the animals within the pasture were not monitored, therefore composite averages for native, tame, shrubland/forest and lowland areas are used to reflect the biomass present. Biomass available to the grazing steers was low at the beginning of the season (300 kg ha^{-1}) peaked during late June (1050 kg ha^{-1}) and then decreased to 325 kg ha^{-1} by the beginning of September. Production levels were approximately 40% of the expected average for mixed native/brome pasture in this area (Hail and Crop Insurance 1999).

Biomass levels under 350 kg ha^{-1} are considered at or under the requirement necessary for growing cattle (Irving, B. pers. Comm.). Thus total biomass production was limiting during the first month of grazing. Significant rain fall (Table 2.3) during the middle of June helped to improve the dry growing conditions in the pasture and encouraged quicker growth. However, by the end of the grazing period, available biomass had decreased to a critical point again. This which would also be expected as the plants mature.

Table 2.5 **Available plant biomass[x] (DM) for each vegetation type measured on entry and exit of cattle from different native/brome pastures during the 1998 grazing season at the Kinsella Ranch.**

Pasture	Sampling Period	Vegetation Type	Grass[y] (kg/ha)	Forbes[z] (kg/ha)	Pasture Average (kg/ha)
1	May 1	Tame	3257	25	
		Native	300	-	
		Shrubland	325	50	
		Lowland	150	25	300
	June 22	Tame	400	-	
		Native	800	-	
		Shrubland	225	125	
		Lowland	225	100	525
2	June 22	Tame	450	150	
		Native	1400	100	
		Shrubland	875	175	1050
	July 20	Tame	400	175	
		Native	1050	50	
		Shrubland	700	300	900
3	July 20	Native	250	225	
		Shrubland	475	125	
		Lowland	475	175	575
	Sept 3	Native	150	100	
		Shrubland	400	25	
		Lowland	275	25	325

[x]values have been averaged to the nearest factor of 25
[y]major native and tame grassland communities are rough fescue (*Festuca scabrella*) and smooth brome (*Bromus inermis*) respectively.
[z]herbaceous broad leaved plants. Includes aster (*Aster spp.*), northern bedstraw (*Galium boreale.*),crocus (*Anemone patens*), fleabanes (*Erigeron spp.),* pea vine (*Lathyrus spp.*), pussy toes (*Antennaria spp.*), rushes *(Juncus spp.*), sage (*Artemisia spp.*), sedges (*Carex spp.*), violets (*Viola adunca*) vetch (*Vicia spp.*), and yarrow (*Achillea lanulosa*).
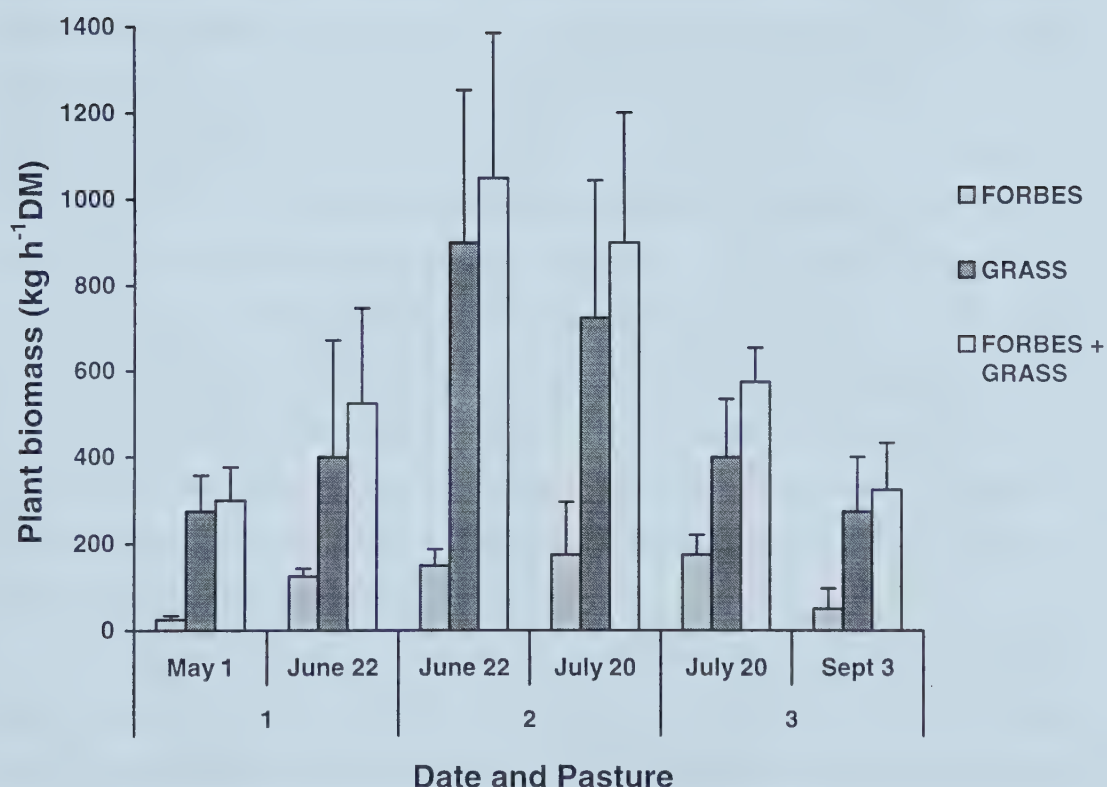
Figure 2.2 Available plant biomass (DM) of three different native/brome pastures measured on entry and exit of cattle during the 1998 grazing season at the Kinsella Ranch

FORBES-herbaceous broad leaved plants. Includes aster (*Aster spp.*), northern bedstraw (*Galium boreale.*),crocus (*Anemone patens*), fleabanes (*Erigeron spp.*), pea vine (*Lathyrus spp.*), pussy toes (*Antennaria spp.*), rushes (*Juncus spp.*), sage (*Artemisia spp.*), sedges (*Carex spp.*), violets (*Viola adunca*) vetch (*Vicia spp.*), and yarrow (*Achillea lanulosa*).

GRASS-major native and tame grassland communities are rough fescue (*Festuca scabrella*) and smooth brome (*Bromus inermis*) respectively.

2.3.3   Pasture quality

The nutritional composition of the summer pastures are shown in Figures 2.3, 2.4 and 2.5. The general trend shows a moderate increase in quality to the middle of the grazing period followed by a drop in quality which was due to increasing levels of fiber and decreasing protein and energy values.

It was expected that the structural fiber values would increase as the plants matured and there were less leaves and more stems within the available dry matter (Perry and Cecava 1995). Moderate increases in fiber observed during the first two months, were probably due to the lower and later rain fall and the subsequent slower start to the growing season. The results indicate that acid detergent fiber (ADF) and neutral detergent fiber (NDF), indicators of forage fiber, increased as the season progressed. ADF is an indicator of dry matter and energy digestibility and the higher the ADF the lower the digestibility. ADF changed from 32.0 % to 38.0 %, indicating a decrease in digestibility. NDF increased from 60.5 % to 68.0 % by the end of the season. Higher NDF values may indicate a decrease in voluntary intake as cattle usually at 1-2 % of body weight as NDF. Intake is a function of rate of digestion, which in turn influences the rate of passage and ultimately the amount of forage an animal consumes (Abouguendia 1998). Thus by the end of the season the animals would have been able to consume less forage.

As expected, the protein content of the pastures (Figure 2.3) declined as the plants matured (Van Soest 1982). Even though they declined throughout the season they were well within the required NRC (1996) range and never fell below the NRC (1996) requirements for growing cattle of this type and weight.

Forage energy values were adequate throughout the grazing period as all except one of the digestible energy (DE) values were above the minimal daily requirement of 2.60 Mcal kg^{-1} (NRC 1996) for cattle gaining at 0.96 kg d^{-1}. The DE value in the last clip was under 2.60 Mcal kg^{-1} however the animals were removed from pasture at this time and would only have had a few days grazing on pasture of this quality. When the animals were removed from pasture 2 the net energy for gain (NE$_g$) was 0.75 Mcal kg^{-1}, however when they were turned into pasture 3 the NE$_g$ was 0.78 Mcal kg^{-1}, which was above the energy requirement perhaps due to the lack of
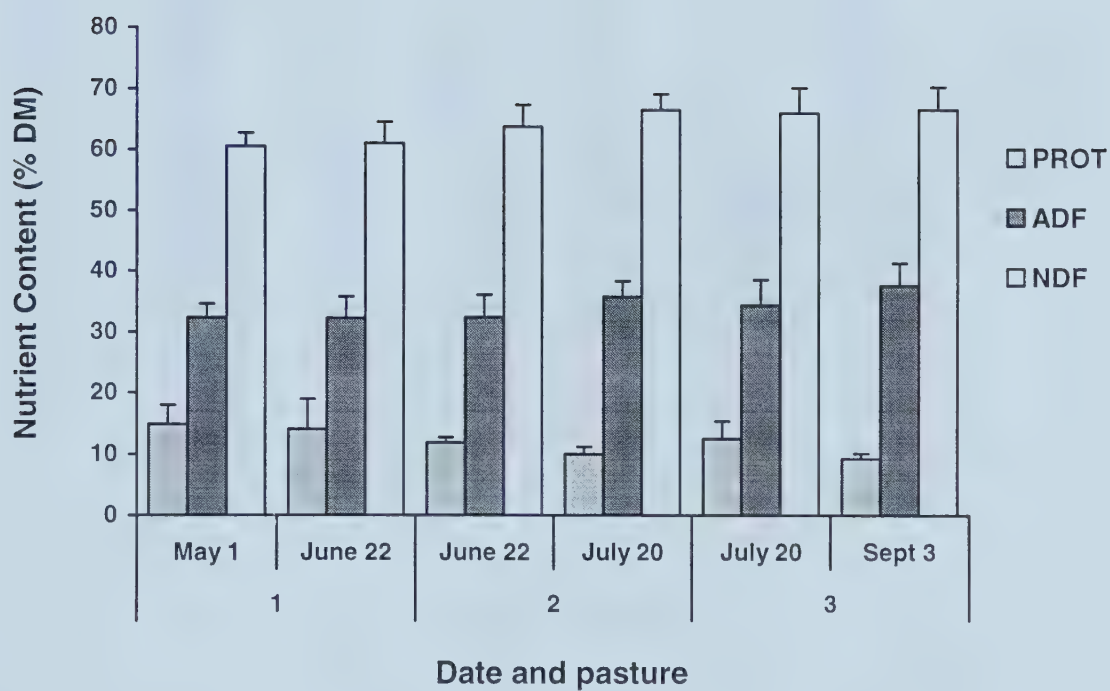
Figure 2.3 Average nutrient content (% DM) of three different native/brome pastures measured on entry and exit of cattle during the 1998 grazing season at the Kinsella Ranch
PROT=protein; ADF=acid detergent fibre; NDF=neutral detergent fibre.
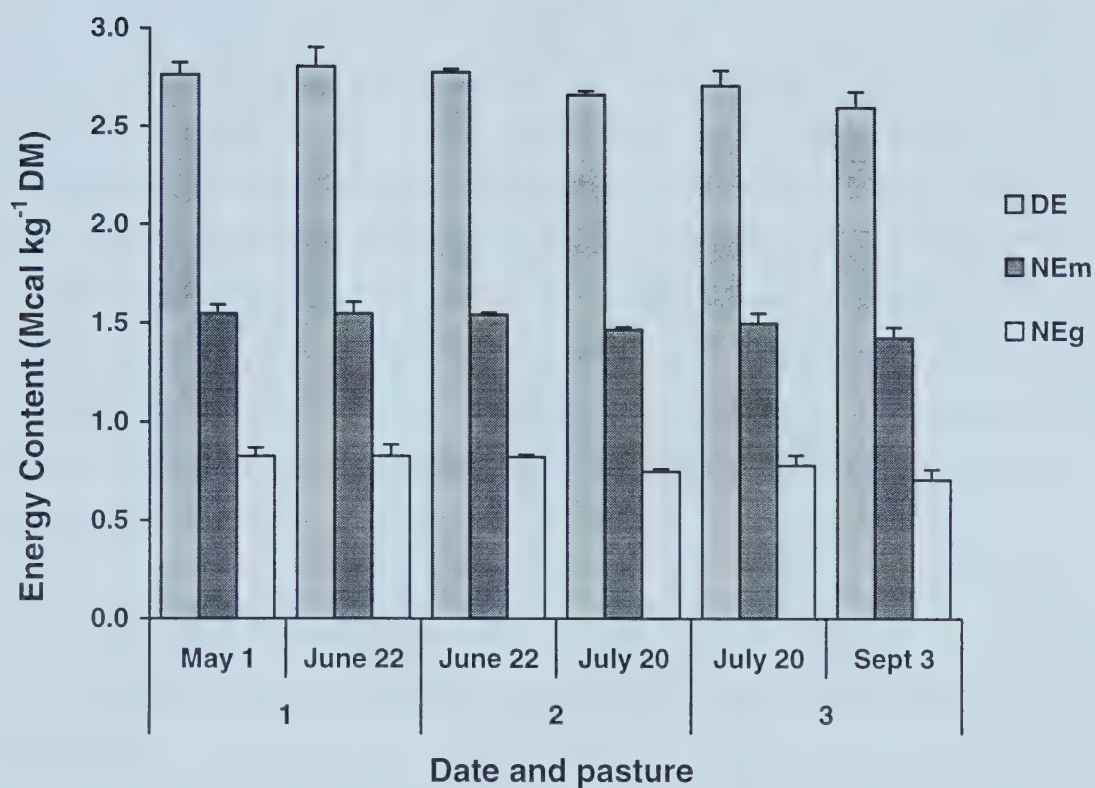
**Figure 2.4 Energy content (Mcal kg^{-1} DM) of three different native/brome
pastures measured on entry and exit of cattle during the 1998 grazing
season at the Kinsella Ranch**
DE=Digestible Energy=(88.9-(0.79 * ADF %))/4.4; NE$_m$=Net energy for
maintenance=077 Mcal/EBW$^{0.75}$; NE$_g$=Net energy for gain=(TDN % * 0.01318) –
0.459);

grazing pressure and forage removal. Final analysis in September showed a decrease of NE_g to 0.71 Mcal kg^{-1}, which would have slowed gains of the cattle on pasture.

Changes in the calcium and phosphorus content of the pastures are shown in Figure 2.5. The calcium content increased from 0.38% in early May to 0.46% by the beginning of September. NRC (1996) calcium requirements for growing steers are 0.30 %, therefore calcium levels in all pastures were more than adequate for the cattle. The soil in which the forages were growing was high in calcium and therefore it would be expected that as the plants grow and bring nutrients from the soil into the foliage, the calcium content would increase (Irving and Baert 2000). Phosphorus was at or below daily requirements of 0.17 % DM for the majority of the grazing season. However the supply of phosphorus within the mineral supplement supplied would have ensured an adequate supply (Table 2.3).

2.3.4   Liveweight animal performance

Complete data were collected on all 72 animals with no death losses experienced.

Liveweight gains of all three groups (Figure 2.6) were similar during the first 29 days on feed due to the supplemental oats supplied during the month of October to the BF and BPF animals. The same average daily gain of 0.68 kg d^{-1} (1.49 lb d^{-1}) was observed for both the BF and BPF treatments during the backgrounding feeding period (Table 2.6). While there are no optimal rates of gain for backgrounding cattle, average daily gains of between 0.5 and 1.0 kg are typical. Rates of gain less than 0.5 kg per day become uneconomical while rates of gain over 1.0 kg per day commonly require a higher input of concentrates and would tend to excessively fatten early maturing types of cattle (Mathison 1993).
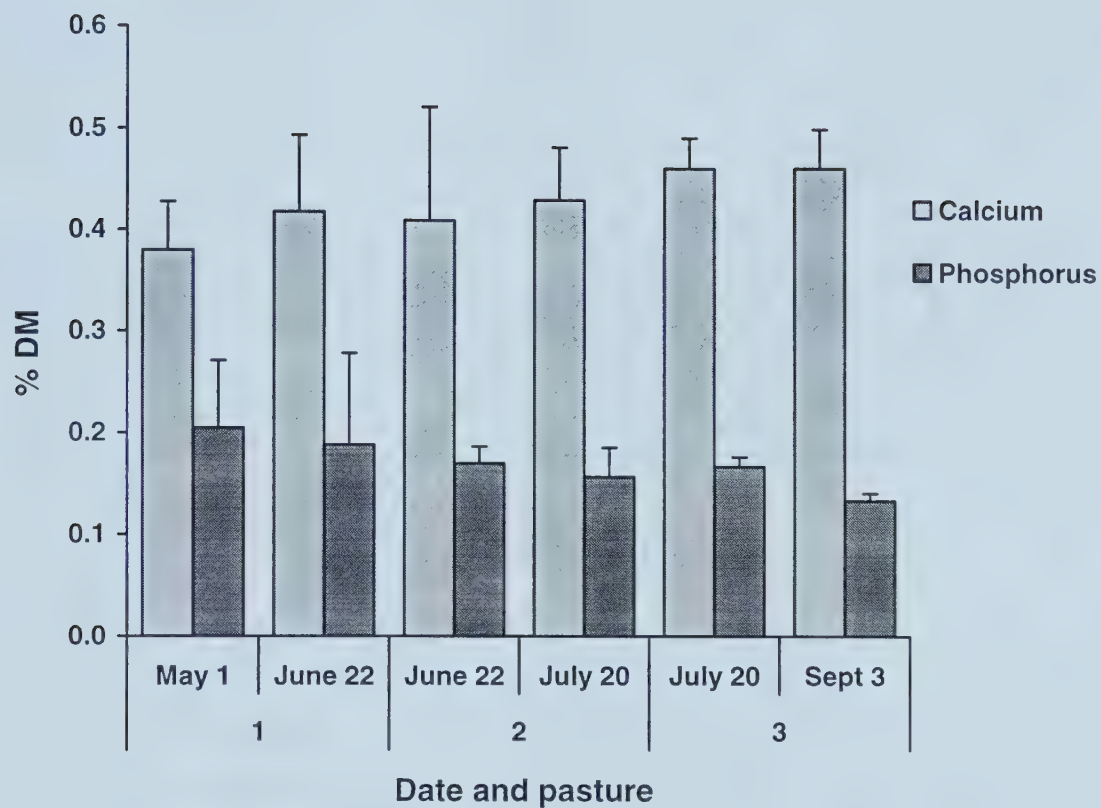
Figure 2.5 Calcium and phosphorus content (% DM) of three different
native/brome pastures measured on entry and exit of cattle during
the 1998 grazing season at the Kinsella Ranch
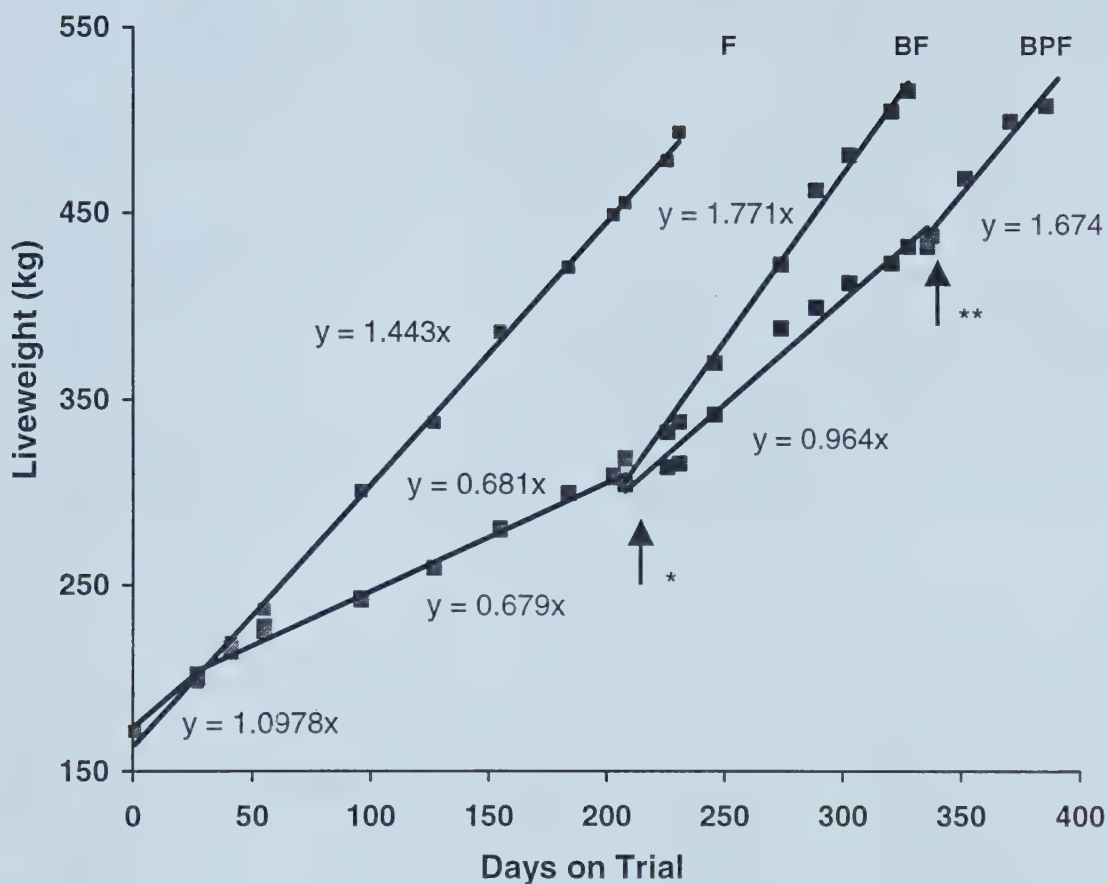
Figure 2.6 Liveweight gain of three treatment groups over time
    F=feed concentrate diet in feedlot only; BF=backgrounded through winter on forage
    and finished on concentrate diet in feedlot; BPF=backgrounded through winter on
    forage, grazed on pasture during summer and finished in feedlot on concentrate diet.
    *Finished backgrounding BF and BPF. BF placed in drylot; BPF placed on pasture
    **BPF steers removed from pasture and placed in drylot.

Table 2.6 Growth performance, feed intake and feed efficiency of three treatment groups

Trait	F Mean	SEM[x]	BF Mean	SEM	BPF Mean	SEM	Prob
INITIAL ANIMAL							
N	24		24		24		
Days old	148	2.30	153	2.30	148	2.30	
Wt (kg)	171.7	4.07	177.5	4.07	174.3	4.07	
HH (cm)	121.0	2.55	118.0	2.55	117.1	2.55	
BCS	2.0	0.01	2.0	0.01	2.0	0.0	
BACKGROUNDING							
Days on feed			207		207		
Wt (kg)			319.7	6.86	315.1	6.86	0.6909
HH (cm)			124.9	0.34	124.4	0.64	0.5915
BCS			2.3	0.06	2.3	0.06	0.6539
Gain (kg)			142.2	6.68	140.8	6.68	0.7074
ADG (kg d^{-1})			0.68	0.02	0.68	0.02	0.9779
Daily DM intake^y (kg d^{-1})			7.20	0.01	7.20	0.0	1.0000
Feed:gain ratio^z (kg kg^{-1}			10.48	0.58	10.59	0.58	0.9422
PASTURE							
Days on feed					128		
Wt (kg)					437.1	5.61	
HH					133.1	0.90	
BCS					3.0	0.07	
Gain (kg)					122.0	3.14	
ADG (kg d^{-1})					0.96	0.03	
BF (mm)					3.40	0.27	
ON ENTERING ADJUSTMENT							
Age (day)	148[a]	2.22	360[b]	2.22	483[c]	2.21	0.0001
Wt (kg)	171.7[a]	5.00	319.7[b]	5.00	437.6[c]	496	0.0001
HH (cm)	121.0[a]	0.79	124.9[b]	0.79	133.1[c]	0.79	0.0001
BCS	2.0[a]	0.05	2.3[b]	0.05	3.0[c]	0.05	0.0001
ADJUSTMENT							
Days on feed	18		23		16		
Wt	183.8[a]	3.08	336.8[b]	3.08	438.5[c]	3.06	0.0001
Gain (kg)	12.1[a]	2.65	17.1[a]	2.66	1.4[b]	2.65	0.0038
ADG (kg d^{-1})	0.77[a]	0.14	0.74[a]	0.14	0.09[b]	0.14	0.0100
Daily DM intake^y (kg d^{-1})	3.35[a]	0.01	6.17[b]	0.01	5.10[c]	0.01	0.0001
Feed:gain ratio^y (kg kg^{-1})	4.36[a]	1.42	8.34[b]	1.42	56.68 [a]	1.45	0.0301
FEEDLOT							
Days on feed	212		103		42		
Wt	491.2[a]	6.08	518.4[b]	6.09	508.4[ab]	6.06	0.0118
HH (cm)	131.2[a]	0.97	132.5[a]	0.97	139.6[b]	0.96	0.0006
BCS	4.5[ab]	0.05	4.0[a]	0.05	3.3[b]	0.04	0.0009
Gain (kg)	307.4[a]	7.09	181.4[b]	7.08	69.9[c]	7.06	0.0001
ADG (kg d^{-1})	1.44[a]	0.04	1.77[b]	0.04	1.67[c]	0.04	0.0087
Daily DM intake^z (kg d^{-1})	9.16[a]	0.15	12.15[b]	0.15	11.07[c]	0.15	0.0258
Feed:gain ratio^z (kg kg^{-1})	6.36[a]	0.17	6.68[b]	0.17	6.63[b]	0.17	0.0363

F=finished in feedlot only; BF=backgrounded through winter and finished in feedlot; BPF=backgrounded through winter, grazed on pasture and finished in feedlot.

[x]standard error of least squares means.

[y]feed intake and efficiency calculated on a dry matter (DM) basis

[a-c]means followed by different letters within rows are significantly different (P<0.05).

When the BF animals were placed onto a high concentrate diet their average daily liveweight gain of 1.77 kg d^{-1} exceeded that of the F animals grown *ad libitum* on the same feedlot diet (1.44 kg d^{-1}) possibly due to compensatory gain. The average liveweight gain of the BPF animals realimented on pasture was 0.96 kg d^{-1}. There were no unrestricted animals fed on the pasture, therefore no direct comparison can be made between the gains of the BPF animals and those of a "control" group. However looking at the liveweight gain growth curve (Figure 2.6) it can be seen that the gains on pasture, while not as great as the BF group in the feedlot, were greater than those during the backgrounding period possibly due to compensatory gain.

It was not expected that the gains on pasture would be the same or even comparable to those animals entering the feedlot after backgrounding due to the lower energy content of the pastures versus the concentrate diet. The overall daily gain of the animals on pasture was 0.96 kg d^{-1}, with smaller gains observed during the beginning and end of the grazing period (Table 2.6). Slower gains during the first month of the grazing period may be explained by the low level of available biomass at the beginning of the growing season (Figure 2.2). While the energy and protein values within the forages were adequate (Figures 2.3, 2.4) there may not have been enough biomass to support the grazing needs of the animals. There are indications in the literature that the major part of compensatory gains is realized in the early stages of realimentation. Lawrence and Pearce (1964) saw gains of 1.8 kg daily during the first month on pasture, declining to 1.5 and 1.2 kg for the second and third months respectively. Horton and Holmes (1978) showed that 50% compensation occurred during the first 10 weeks of grazing. In the current experiment the majority of compensation did not occur during the first month due to the low pasture quality. Rather the high rates of catch-up gain occurred during the second and third months. The slow gains during the first month on pasture were followed by 80 days at a high compensatory rate of gain indicating that the animals had acclimatized by this point and the energy levels were adequate to allow them to compensate (Figure 2.6).

Average daily gains of 1.67 kg d^{-1} by the BPF group in the feedlot were significantly (P<0.05) greater (+0.23 kg d^{-1}) than the F animals unrestricted on the same concentrate diet. Normally animals would not require a second period of catch-up growth following summer grazing. However in this case the decreasing quality of the forage and the subsequent drop in gain resulted in a second, short period of restriction. The BPF animals did not exhibit feedlot gains as high as the BF group following backgrounding, because the restriction during the backgrounding period was more severe and promoted faster weight gains. Also the BPF steers had already partially recovered from prior restrictions during their time on pasture.

During transportation to the abattoir liveweight shrinkage differed among treatments, ranging from 3.7 % bodyweight for the BPF animals to 4.8 % and 5.0 % for the BF and F animals respectively. This may be due to differences in age, weight, daily temperature, feed, transit style and slaughter environments (Agriculture Marketing Manual 1999).The BF animals were slaughtered in August 1998 compared to October 1998 for the BPF animals and the warmer temperatures in August may have increased water loss in the BF animals. The F animals were transported as one lot to Brooks which required a larger and different style of truck compared to the BF and BPF animals which were transported in two groups of twelve. Shrinkage differences may also be due to different handling and processing procedures between the Lacombe and Brooks abattoirs. Differences in feed should not have influenced shrinkage rates as all three groups had over 40 days on ad libitum concentrate, however the animals finishing off pasture had a smaller shrinkage. McCaughey and Cliplef (1996) also showed that the animals slaughtered directly off pasture had the lowest shrinkage values. They attributed this difference to varying environmental conditions on the different slaughter dates.

2.3.5 Changes in body measurements

There were no significant differences (P<0.05) in body weight, body size (hip height) or body condition score (BCS) between the BF and BPF groups after the 207 day backgrounding period (Table 2.6). The BF animals grew an average of 6.9 cm in hip height and changed from a BCS of 2.0 to 2.3, while the BPF animals grew 7.4 cm and changed from a BCS of 2.0 to 2.3. The backgrounding period was designed to bring these two groups of animals through the winter at the same level of gain and body growth. These results indicate that the goal was achieved.

On average, a gain of 8.7 cm in hip height was achieved by the BPF animals during the 128 day summer grazing period. Their body condition score was 3.0 by the end of the summer; and their backfat was 3.40 mm thick. The possibility of marketing the cattle as a group directly off pasture did not exist as 58% were under the minimum 4 mm subcutaneous backfat thickness required for Canada A grades. In addition it is doubtful that the majority of animals would have had the trace level of marbling required for Canada A grade and so would have graded B1.

42% of the animals had met the minimum fatness indicating they had the potential to finish, however the overall low quantity and quality of the pasture limited the rate of liveweight gain (especially in the late grazing season) and slowed the fattening necessary for finish. If a higher quality pasture had been used the possibility of finishing more cattle would increase. McCaughey and Clipleff (1996) were successful in finishing 69% of animals directly off pasture after 160 days on a 70% alfalfa/ 20% meadow nromegrass/10% wildrye pasture. They did observed that a finishing period of 33 or 72 days resulted in increased return over those marketed directly off pasture and suggested that to reduce the risks of carcasses being discounted for lack of finish a short grain-feeding period appeared necessary.

It is important in pasture and forage feedings systems that the appropriate type of cattle are used. Calves of British breeding such as Hereford, Angus and Shorthorn are best suited to a slow rate of gain after weaning because they are early maturing and tend to fatten at a light weight if put directly in a feedlot after weaning. Later maturing cattle such as Charolais, Simmental and Holstein are not suitable for a backgrounding and pasture operations since they will not reach the desired degree of

fatness at an optimum slaughter weight unless they are given a high energy diet after weaning (Mathison 1993).

The animals that went straight into the feedlot following backgrounding (BP) increased in hip height by 7.5 cm and had a BCS of 4.0 at slaughter, an increase of 1.7 units in 126 days. While compensatory gains were made by both groups of animals following backgrounding, a clear distinction must be made between the growth results obtained under pen feeding conditions and those under grazing. While both groups experienced growth, more fat was deposited by those animals in the feedlot. The reason for this is that while the energy values of the pasture were sufficient to allow true (non-fat) growth, they were not high enough to allow for additional fat deposition. Conversely, the high energy values in the feedlot ration were above and beyond maintenance levels and allowed fat deposition.

As expected there was a significant (P<0.05) treatment effect on the size and condition of the animals on entry into the feedlot (Table 2.5). The animals in the unrestricted all-concentrate feeding program (F) entered the feedlot directly after weaning and were 5 months old (148 d) with a hip height of 121.0 cm and a BCS of 2.0. In comparison the BF group were almost one year old (360 d) and had a hip height of 124.9 cm and a BCS of 2.3. The BPF were the oldest at 16 months (483 d), the tallest (133.0 cm) and had the highest body condition score (3.4) on entry into the feedlot.

The final hip heights, backfat and age of the animals at slaughter were also significantly (P<0.05) affected by the different feeding programs. The animals which were fed the all concentrate ration (F) finished quickly and were the youngest, smallest and fattest when finished (500 kg). In comparison those animals which were backgrounded, grazed and then finished in the feedlot (BPF) were the oldest, largest and had the least amount of backfat at 500 kg. The intermediary group which was backgrounded and then finished in the feedlot (BF) was between the other two groups in terms of size, age and finish level of backfat. Bone growth is only affected by nutritional restriction in extreme situations (Price 1976, 1977).

The differences in hip heights at slaughter were not attributed to differences in nutrition but rather were due to differences in age. The nutritional restriction imposed

was not drastic enough to stunt growth and development. Also the older an animal is the larger it will be at the same level of finish (Berg and Butterfield 1976). Thus if the BF and BPF animals had been finished to the same level of finish as the F animals they would be older and taller.

2.3.6   Feed intake and efficiency

Daily *ad libitum* DM forage intakes (Table 2.6) did not differ between the BP and BPF groups during the backgrounding period. There were also no differences in feed conversion efficiency. Hay wastage could affect the feed to gain ratio of the BF and BPF animals. However since these animals were fed the same forage under the same circumstances the feed wastage is assumed to be similar between groups. No estimate was made of pasture intake during the recovery period of the BPF animals, therefore feed efficiency and intake data are not presented for that period.

There was a significant differences in feed intake and feed efficiency between the three treatment groups during the adjustment period (Table 2.6). The F animals had the lowest daily intake and feed to gain ratio. This can be attributed to their smaller size on entering the adjustment period and also the stress of being recently weaned and castrated. The BF group had the highest intake followed by the BPF animals. Figure 2.7 shows that while the BF animals had lower intakes than the BPF over the first 16 days, the additional five days spent at full feed increased their overall average daily intake value. Greater size of the rumen in the older animals and increased intakes due to compensatory gains may explain why the BPF and BF animals had greater DM intakes.

Due to the lack of gains in the adjustment period the BPF animals had the highest feed to gain ratio. It is expected that the BPF animals would have had a greater gut fill at the end of the grazing period and the subsequent loss of gut fill during the adjustment period would account for the lack of observed weight gain. The loss of weight in animals adjusted from pasture to feedlot has been observed by Lawrence and Pearce (1964). The BF animals were also on a forage diet, however they did not experience the same loss of gut fill as the BPF animals. These animals were adjusted to the feedlot ration while still in the backgrounding pens and the lack

of location change combined with the longer feeding period may have reduced the shock of adjustment.

The BF and BPF animals had significantly higher ($P<0.05$) dry matter intakes in the feedlot compared to the F animals. Of all the factors considered to have a possible influence on compensatory liveweight gains, an increased appetite resulting in an increased food intake is generally though to be the most important in the majority of circumstances (Lawrence and Fowler 1997). Fox et al. (1972) Madder et al. (1989) and Ryan et al. (1993) reported that cattle placed on full feed after a period of restriction have increased feed intakes. In this study increased efficiency of feed utilization did not occur in the realimented animals, which would indicate that the compensatory gains were due to increased intake and not increased feed efficiency. Efficiency is mainly a matter of live weight with lighter animals being more efficient due to a lower maintenance requirement (Carstens et al. 1989), thus the F animals should have had a lower efficiency than the BPF and BF animals.

Five day average intakes (Figure 2.8 and 2.9) show the expected increased feed consumption during the feedlot and backgrounding periods. Large fluctuations in intake may be explained as natural variations in feeding behaviour and by animal response to changes in daily temperatures (Basarab et al. 2001). Intake is strongly correlated with ambient temperature and large variations may be explained by significant changes in temperatures such as during a winter blizzard or a heat wave in summer. During the last 40 days of the F feedlot period (Figure 2.9) intakes fluctuated widely and began to level off. This may be due to seasonal effects, but is also probably because the animals were approaching a finished state. Intakes may also decrease in response to sickness and ill health such as acidosis, however in this study there were no evidence of acidosis or bloat in any of the seventy two animals in the feedlot diet.
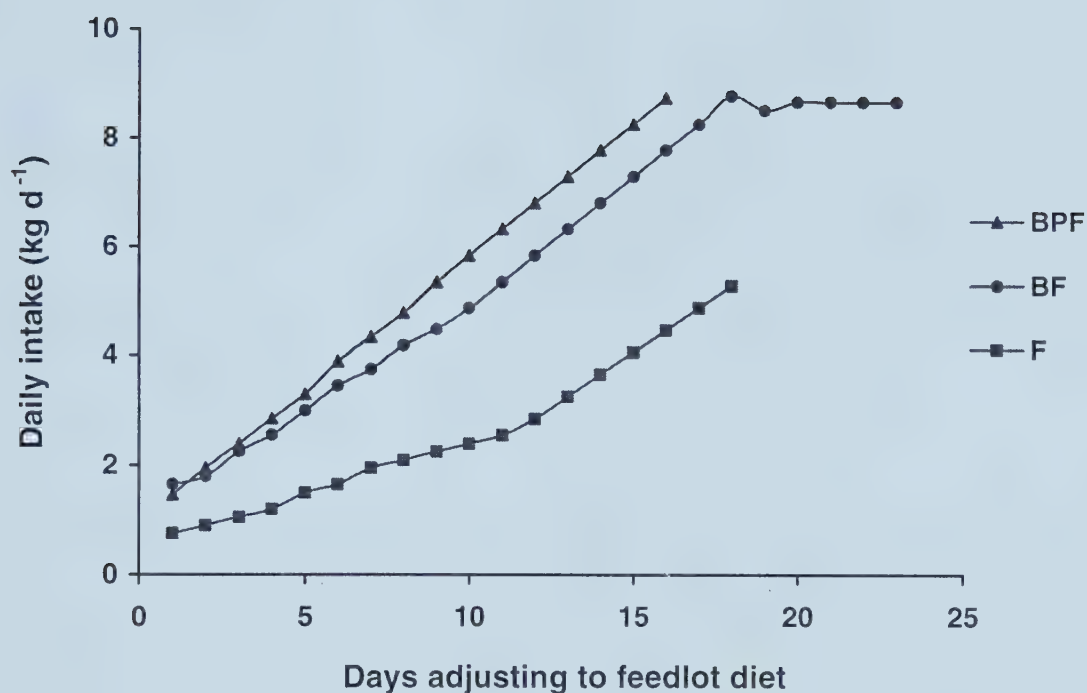
Figure 2.7 Average daily intake for the three treatment groups during the adjustment period

Adjustment period=transition stage where animals are fed decreasing amounts of forage and increasing amounts of concentrate until reaching ad libitum intake of concentrate diet only.

F=finished in feedlot only; BF=backgrounded through winter and then finished in feedlot; BPF=backgrounded through winter, grazed on pasture and then finished in feedlot.
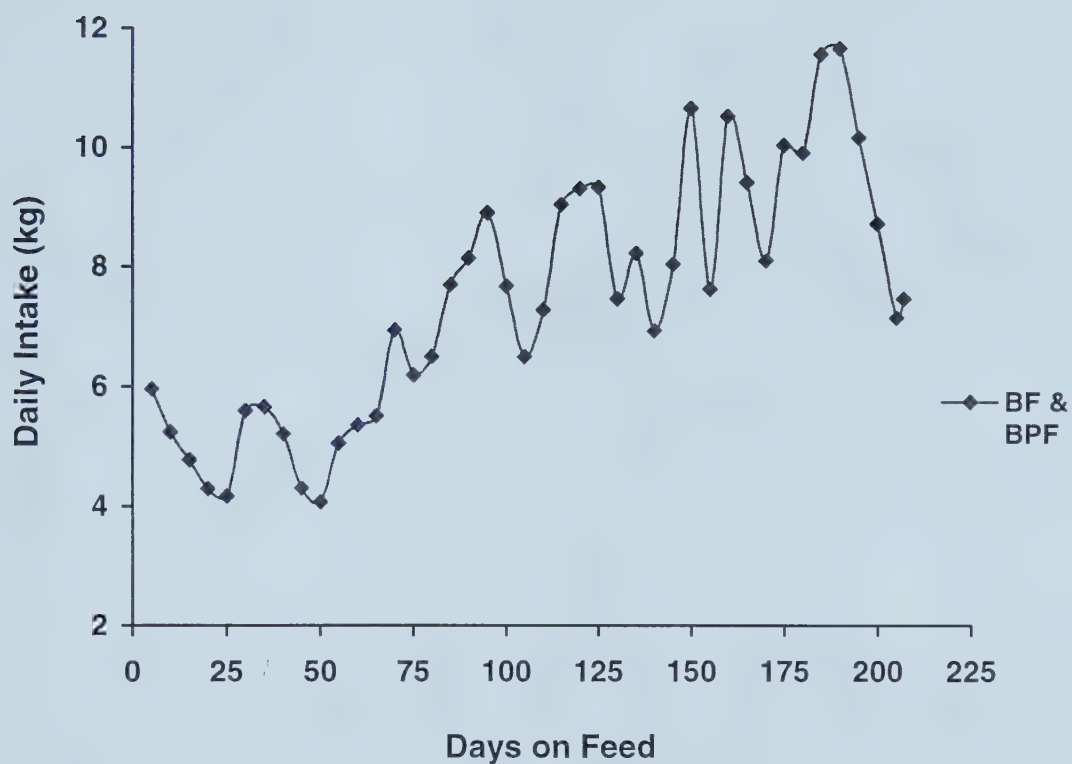
Figure 2.8 Five day average daily intake for the BF and BPF treatment groups during the backgrounding period
BF=backgrounded through winter and then finished in feedlot; BPF=backgrounded through winter, grazed on pasture and then finished in feedlot.
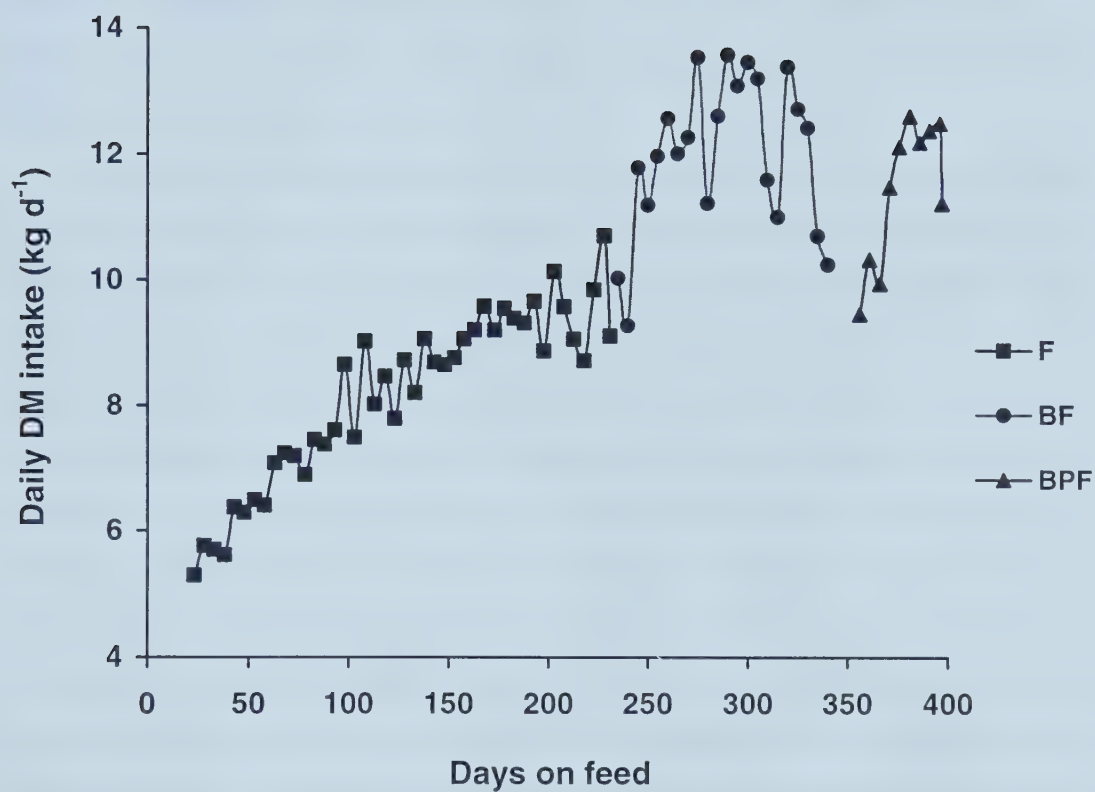
Figure 2.9 Five day average daily intake for the three treatment groups during the feedlot period

F=finished in feedlot only; BF=backgrounded through winter and then finished in feedlot; BPF=backgrounded through winter, grazed on pasture and then finished in feedlot.

2.3.7   Carcass characteristics

Carcass weights and grading information are shown in Table 2.7. While treatment did have an affect on the final slaughter liveweights of the slaughter animals, no significant differences (P<0.05) in warm carcass weights were seen. Warm carcass weights averaged 268.3 kg, 277.6 kg and 271.3 kg for the F, BF and BPF feeding treatments respectively.

Carcass fat cover (grade fat) at the 12th rib ranged from 10.2 mm to 5.6 mm with the F animals having the most backfat and the BPF the least. Marbling scores indicate that there was a differences in the degree of intramuscular fat between the animals finished in the feedlot (F) and those backgrounded and then finished (BF). The BPF group had significantly (P<0.05) less intramuscular (marbling) fat within the rib-eye muscle. This trend was also supported by the grade data. All animals except one graded Canada A, AA or AAA. Approximately 2/3 of all the animals in each group graded AA. Group F split the remaining 1/3 between the A and AAA grade categories, while the rest of the BF group graded AAA with one B1 animal. All of the other BPF animals graded Canada A. This shows that while the F group had the fattest animals they did not have the highest percentage of AAA animals indicating that the high level of fat deposited in the feedlot period did not necessarily translate into the highest levels of marbling (intramuscular fat). This is supported by Berg and Butterfield (1976) who indicate that marbling is a late maturing depot and younger animals will have less than older animals. There was no evidence of yellow fat in any of the carcasses regardless of management regime.

That only one animal graded Canada B1 in the entire study and that it did not appear in the BPF group is noteworthy. The BF animal graded Canada B1 only because it had less than a trace of marbling, which is required to make the Canada A grade. This animal had a final slaughter weight of 495 kg with a grade fat thickness of 4mm and had been a consistent "poor doer" throughout the study.

Cattle backgrounded, pastured and then finished on grain had approximately 2 % higher lean yield (60.74 %) than cattle that were fed grain only (58.56 %) and

Table 2.7 Carcass characteristics of three different treatment groups

Trait	F Mean	SEM^w	BF Mean	SEM^w	BPF Mean	SEM^w	Prob.
N	24		24		24		
Age days (mo)	377 (13)		479 (16)		540 (18)		
Live weight (kg)	491.2^a	6.08	518.4^b	6.09	508.4^b	6.06	0.0118
Warm Carcass Wt (kg)	268.3	4.08	277.6	4.81	271.3	4.79	0.1798
Shrink (%)	5.0		4.78		3.74		
Dressing percentage(%)^x	57.12^a	1.0	56.31^b	0.98	55.54^c	0.95	0.0263
Grade Backfat (mm)	10.19^a	0.53	8.55^b	0.53	5.64^c	0.53	0.0325
REA (cm^2)	74.03	2.31	73.94	2.31	69.69	2.30	0.1879
Marbling score ^{y}	4.40^a	0.11	4.71^a	0.11	3.93^b	0.11	0.0469
Est. Cutability (%)^z	58.56^a	0.96	59.37^b	0.98	60.74^c	0.95	0.0125
Yield Grade							
Y1 (%)	7 (29.2)		11 (45.8)		21(87.5)		0.001
Y2 (%)	14(58.3)		12 (50.0)		3 (12.5)		0.003
Y3 (%)	3 (12.5)		0		0		0.044
Quality Grade							
B1 (%)	0		1 (4.2)		0		0.363
A (%)	3 (12.5)		0		8 (33.3)		0.005
AA (%)	17(70.8)		17 (70.8)		16(66.7)		0.937
AAA (%)	4 (16.7)		6 (25.0)		0		0.039

F=finished in feedlot only; BF=backgrounded through winter and then finished in feedlot;
BPF=backgrounded through winter, grazed on pasture and then finished in feedlot.
^{w}standard error of least squares means.
^{x}dressing percentages were calculated as warm carcass wt/shrunk liveweight x 100
^{y} marbling score is a measure of the intramuscular fat: trace marbling or less=1.0 to 3.9 (Canada A quality grade); slight marbling=4.0 to 4.9 (Canada AA quality grade); small to moderate marbling=5.0 to 7.9 (Canada AAA quality grade); slightly abundant or more marbling=8.0 to 11.0 (Canada Prime).
^{z}cutability estimates were calculated as: 57.96 – (0.027 x warm carcass weight, kg) – (0.703 x average backfat thickness, mm) + (0.202 x rib-eye area, cm^2
$^{a-c}$ means followed by different letters within rows are significantly different (P<0.05)

1.4% higher than those backgrounded and then finished on grain (59.37 %). Since all three groups had similar carcass weights and degree of lean (rib-eye areas not significantly different P<0.05) within the carcasses the differences in cutability were mainly due to differing proportions of fat within the animals.

Cutability estimates calculate the amount of saleable meat within the carcass. Since the high grain-fed animals (F) had a large amount of excess subcutaneous backfat that had to be trimmed off this would greatly decrease the amount of product available from the carcass. The BPF animals had significantly less back fat than the F animals (5.6 mm vs. 10.2 mm) and a much larger frame size (HH = 139.6 cm vs. 131.2 cm) and lean deposition within the carcass. Since mostly lean is included in the salable cuts a higher cutability estimate would be the result of more lean. The yield grade values also reflect this trend with the majority of the BPF carcasses falling into the Y1 category. The BF carcasses were almost evenly split between theY1 and Y2 categories, while over half of the F carcasses graded Y2.

Drennan and Harte (1979) also showed that carcasses of animals reared on a higher plane of nutrition had a greater percentage of fat, lower percentage of meat and a lower percentage of bone compared to those reared on a lower plane of nutrition. McCaughey and Cliplef (1996) however showed that animals finished directly off the pasture had lower cutability estimates compared to animals that were fed barley for either 33 or 75 d following pasture grazing. This was because their pastured animals were slaughtered first and were consequently younger than the other two groups. In addition no restriction had occurred to inhibit fat deposition.

It is obvious that while the BPF animals had sufficient fat to grade Canada A in only 58 days on grain in the feedlot, they did not have the same level of finish (fat and marbling) as the other two groups. It is reasonable to say that given enough time in the feedlot it would be possible to bring the BPF animals to the same level of backfat and probably the same degree of marbling. However since marbling is a function of age the BPF animals would have a higher degree of marbling than the F and BF animals at the same fat thickness. Higher levels of marbling would increase the number of animals with higher grades resulting in improved quality and better valued carcass (if sold by railgrade). Since most of their growth had already been

obtained by the BPF when they entered into the feedlot and mostly fat was being deposited, a balance between marbling and excess backfat would have to be met.

Dressing percentages decreased as the level of forage in the treatment groups increased and were 55.54 %, 56.31 % and 57.12 % for the BPF, BF and F animals respectively. Research conducted at the Lethbridge Research Station (Bailey 1984) and the University of Alberta (Jones et al. 1978) indicate that cattle on high roughage diets such as hay, silage or pasture have a lower dressing percentage than cattle on a high proportion grain diet, even if marketed at very similar levels. The reasons for the decrease were due to increased gut fill and reduced amounts of carcass fat as the roughage level increased.

Dressing percentages are of interest to the beef industry as they are used to establish the weight upon which payment is calculated for animals sold on a railgrade basis. A higher dressing percentage may contribute to a higher railgrade price. However higher railgrade prices do not always occur as other carcass quality factors such as fat thickness will affect the calculated price (Agriculture Marketing Manual 1999).

2.4 CONCLUSION

Both groups of cattle restricted through the winter were able to fully regain their liveweight and were able to satisfactorily meet Canada A grade standards. While catch-up growth was experienced by the BPF animals during the grazing period, it was not possible to finish the animals to a commercially acceptable fat level on mixed native/brome pastures due to the low level of energy within the forage. The BPF animals experienced a second period of catch-up growth following grazing. Higher feed intakes which led to higher daily gains were observed by both backgrounded groups in the feedlot period.

Treatment did not have an effect on warm carcass weight or rib-eye area however it did affect, estimated cutability, yield grade and quality grade. While the BPF animals had the highest cutability and yield grades due to a greater lean depot, they did not have the same level of finish as the other two groups. The F group were the fattest at finish yet they did not have the highest percentage of AAA animals indicating that the high level of fat deposited in the feedlot period did not necessarily translate into high levels of marbling. This would be expected since marbling is an age related depot. Animals finished exclusively in the feedlot also had the lowest yield grade and cutability estimates due to excess backfat.

No evidence of yellow fat was apparent and only one "poor doer" animal in the BF group graded Canada B1 due to less than a trace of marbling. Animals can attain an acceptable level of finish and quality when forage and pasture is incorporated into the wean to finish period.

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CHAPTER THREE

Cost Benefit Analysis of Three Finishing Alternatives

3.1 INTRODUCTION

In general, the evidence suggests that a period of feed restriction when followed by a sufficiently long recovery period of unrestricted feeding results in equal or better overall efficiency of feed utilization when animals are slaughtered on a weight constant basis (Wilson and Osbourn 1960). The cheapest feed for cattle is grazed grass, the next is conserved grass, and purchased concentrates are the most expensive (Farm Operation Cost Guide 1999). Therefore, if inputs of winter feed and particularly concentrates in the finishing period can be reduced without affecting overall efficiency of feed utilization, economic advantages should arise.

Backgrounding is a sector of the cattle industry, which utilizes roughages to grow out, rather than fatten calves before they are fed a high-energy diet in the feedlot. Backgrounded animals are wintered at a low rate of gain and then are either put on pasture or in the feedlot to capitalize on compensatory gains (**CHAPTER TWO**). Backgrounding serves as a strategic method to decrease feed costs which are the highest input costs.

In his literature review of compensatory gain, O'Donovan (1984) stated that while complete compensation is rarely achieved on pasture it represents a considerable gain at a low cost. A double saving ensues, in that feed costs are minimized during restriction when there are rapid gains on low cost pasture. While the ability of growing animals to exhibit catch-up growth after a period of under nutrition is widely recognized and exploited by producers, the extent to which short-term undernutrition is desirable in attempting to optimize the efficiency of feed use or the costs of production has not been clearly defined (Baker et al. 1985).

Grazing trials at the Brandon Research Centre (Brandon, Manitoba) have shown that gains on pasture can cost as little as $0.66 kg^{-1} in comparison to Canfax estimates (Canfax Market Summary 1997) of feedlot gains costing from $1.44 to $1.89 kg^{-1} in Alberta and Ontario, respectively. It has also been reported that beef cattle gains on pasture in Canada can be achieved at less than 40% of the cost of grain

feeding (McCaughey and Cliplef 1996), even without taking into account death and morbidity losses from grain as compared to forage feeding (Mwansa et al. 1992). Other advantages of pasture as opposed to feedlot finishing are reductions in tag, liver abscesses and carcass bruising all of which were identified in the Canadian National Baseline Quality Audit as important sources of loss to the Canadian beef industry (Winslow 1996).

Most beef cattle in Alberta are finished on intensively fed barley diets (Anderson 1985). This has many clear advantages including maximum animal growth rates, enhanced marbling, white fat and uniform quality carcasses available all year round (McCaughey et al. 2000). But there are also a number of disadvantages including health concerns (chronic bloat, acidosis, liver abscess, laminitis, death) (McCaughey et al. 2000) and a serious economic vulnerability to high and fluctuating grain prices (Novak and Viney 1995).

Utley et al. (1975) indicated that the selection of an economical cattle finishing system is primarily dependent on market specifications, the type of feed available and the cost per unit of gain. While cattle can utilize many feed resources unsuitable for human consumption (**see CHAPTER ONE**), the key to their implementation is the competitive economic return afforded the producer by implementing them.

The objective of this study was to estimate and compare the production costs and returns of a traditional feedlot finishing program (F) with those for two higher forage feeding programs which combined backgrounding with a shortened feedlot finishing period (BF) and pasture grazing followed by feedlot finishing (BPF) under different market conditions.

3.2 MATERIALS AND METHODS

3.2.1   Animals and experimental design

This study used data from the seventy two cross-bred beef steers described in **CHAPTER TWO**. Briefly, on October 2 1997 these steers were allocated randomly to three treatment groups (Figure 2.1) of 24 animals each. The F (Feedlot) animals were gradually adjusted to a balanced high concentrate diet over eighteen days and then fed *ad libitum* until finished (500 kg). The BF (Background/Feedlot) animals were backgrounded through the winter on an energy restricted diet of brome hay until April 27, 1998 when they were moved from the backgrounding pens into the feedlot pens. They were adjusted to a feedlot diet over twenty three days and then fed *ad libitum* until reaching market readiness (500 kg). The third group, BPF (Background/Pasture/Feedlot), were also backgrounding through the winter on an energy restricted brome hay diet. On April 27, 1998 they were placed onto pasture. Three different native/brome pastures were utilised throughout the summer with the first one being grazed for 56 days, the second for 28 days and the third for 44 days. On September 2, 1998 they were removed from the pasture and placed into feedlot pens where they were gradually adjusted to a concentrate diet over 16 days. They were then fed the concentrate diet in the same fashion as groups F and BF until reaching market readiness (500 kg).

Market readiness was determined on the basis of liveweight. Animals were considered ready for slaughter when a pen average liveweight of 500 kg was reached. Feed was weighed and delivered each morning to the animals in the feedlot pens. Animals in the backgrounding pens were fed as required every 2-4 days. Barley straw was used for bedding and was delivered to feedlot and backgrounding pens as required. Appropriate salt, mineral and vitamin supplements were provided free choice in the backgrounding and pasture pens, and within the concentrate ration in the feedlot pens. Dates and amounts of feed, bedding and supplements delivered to the pens was recorded throughout the trial. All veterinary and medical expenses were recorded, including costs of medicine and number of treatments given per animal.

3.2.2   Economic data sources

Data collected for the economic analysis included:

1) feed barley and oat prices

2) grass hay prices

3) feeder prices for various weight groups

4) slaughter cattle prices for both liveweight and railgrade categories

5) premix supplement, alfalfa pellets, salt, mineral and vitamin prices

6) veterinary and medical costs

Weekly price averages for the period January 1993 through December, 1998 (6 years) were assembled for feed barley, oats, and feeder and slaughter (liveweight only) cattle for the Central Alberta area (Agriculture Statistics Yearbook 1992-1998). Yearly average barley straw and grass hay prices were collected for the period of 1996 to 2000 for the Edmonton area (Yearly Hay Price List 2000). The hay prices reflect average amounts paid for all types of grass hay and while this study used mixed brome hay, the estimated value would be fairly close to the actual market values. An annual all-item Consumer Price Index (CPI) was applied to all the prices to remove the effect of inflation and equalize them to a 1998 dollar standard (Agriculture Statistics Yearbook 1998). Cereal and livestock prices were then averaged for a monthly value while a yearly average was determined for the hay. The prices used in the ration calculations for the alfalfa cubes, premix supplements, salt, minerals and vitamins were the actual purchase prices as of October 2, 1997. Alberta Agriculture indicates that the statistical data in the yearbooks were obtained from various sources, with the majority of contributions being the Agriculture division of Statistics Canada. The Agriculture Financial Services Corporation (AFSC) which provided the hay values relies on industry support for their averages.

Feeder steer prices were collected for each of the seven weight categories (45.4 kg increments starting at 136 kg with the last category being 408+ kg). These prices were averages reported by Edmonton area auction markets and represent average cattle available during each particular time period.

Slaughter liveweight price data were based on direct live cattle delivery to Alberta processing plants. With more of the packing industry located in Southern Alberta, these prices would tend to reflect the price around Calgary and not Edmonton, however prices were not adjusted (by adding freight charges) to account for this difference. Liveweight slaughter prices were based on a buyer's estimate of the carcass weight and the current carcass price for the particular gender and type class (steer, heifer, cow or bull).

The railgrade price is determined on a per carcass basis and is calculated by applying premiums and discounts for carcass weight, quality grade and yield grade to a market value based price. In this study premiums and discounts were applied to individual carcasses using a sliding scale, based on grade and the amount the carcass weight was below or above the target weight range (250 kg – 385 kg). Premiums were applied to Canada AAA and Canada AA quality grade carcasses and discounts to Canada Y2, and Canada Y3 carcasses on a per kg price. The premium/discount grid used in the economic analysis are shown in Table 3.1.

Table 3.1 Slaughter premium/discounts ($ kg^{-1}) used in economic analysis[1]

Grade	Y1	Y2	Y3
CANADA AAA	+ 0.2424	+ 0.1763	+ 0.0661
CANADA AA	+ 0.0661	base price	- 0.2204
CANADA A	- 0.0220	- 0.0882	- 0.3068

[1] data collected for the month of May 1998 from Alberta Agriculture Statistics Branch
base price is equal to a Canada AA and Y2 carcass

Further discounts were applied to B1, underweight and overweight carcasses are shown in Table 3.2. Railgrade prices are reflective of the current market situation and are only snapshots in time. Railgrade base slaughter prices were therefore only collected for the months animals were shipped to the abattoir (May, August, September 1998) and the premium/discount grid from May 1998 applied to all.

Table 3.2 Slaughter discounts ($ kg^{-1}) for underweight and overweight carcasses[1]

Item	Amount
B1	0.7714
< 250kg	- 0.5510
386-407	- 0.1102
408-430	- 0.4408
> 431	- 0.7714

[1] data collected for the month of May 1998 from Alberta Agriculture Statistics Branch

3.2.3   Gross margin analysis

A gross margin is the difference between the gross income and variable costs of an enterprise. Gross margin analysis separates the production process into individual units (enterprises) in order to evaluate the specific revenue and expenses for each segment (Casavant and Infanger 1984). Gross margins are generally quoted per unit of the most limiting resource such as per head of animal. From this analysis it is possible to determine the effect that a business decision will have at the smallest possible level.

Gross margins are not a measure of the profit of a particular enterprise as they do not include fixed costs such as insurance, taxes, interest on term liabilities and depreciation on pre-existing facilities (Debertin 1986), which have to be met

regardless of whether or not production takes place or is completed (Debertin 1986). When estimating the profit of a production unit it is necessary to consider these overheads in addition to enterprise gross margins.

Categorization of a cost item as fixed or variable is not always clear and is closely tied with the particular period involved. Over long periods of time a producer is able to buy and sell land, machinery and other inputs and generally all costs are treated as variable. However during short term periods, adjustments to inputs would not occur and all costs would be fixed. In this study labour, which contains elements of both fixed and variable costs, was not included in the gross margin analysis because its availability was independent of the type of enterprise being considered. Regular paid labour was considered an overhead fixed cost as it could not be allocated to one particular enterprise.

The gross margin for each enterprise (treatment group) was calculated by subtracting the total variable costs of production from the market value of the steers at slaughter. All calculations were based on an as fed basis.

Gross Margin = Market Value of Produce - Total Variable Costs of Production

The market value of the steers refers to the income derived from selling the finished steers for slaughter and was calculated on both a liveweight and railgrade basis. Liveweight income was determined by multiplying the slaughter liveweight (less 3% shrink) by the liveweight selling price for the month in which the animals were slaughtered. Railgrade income was calculated by multiplying the individual warm carcass weights by the appropriate railgrade carcass price (including discounts and premiums for carcass weight, quality grade and yield grade) and then averaging this value for the 24 animals within each group. A shipping fee (Alberta Feedlot Management Guide 1999) was applied only when the animals were sold for slaughter and commission was calculated as 3% of the total liveweight value (Alberta Feedlot Management Guide 1999).

The total variable costs of production included only those costs associated with buying, feeding, and maintaining the animal from Day 1 (October 2, 1998) to

delivery at the abattoir. The total costs of production were calculated on a per animal basis and then averaged for each group of twenty four animals. Variable costs were divided into two main constituents: (1) the cost of the feeder animal and (2) the cost of gain.

Feeder animal costs were calculated as the weight of each animal on October 2, 1997 multiplied by a standard 6 year average feeder buying price for October. The same price was used in order to present a uniform and equal financial starting point for subsequent economic comparisons. Induction costs, which included veterinary fees for castration and an 8-way vaccination were also included. In this study expenses involved in initial purchasing and transporting (commissions paid to order buyers, trucking cost, shrink and death losses) did not apply as the animals were already on location and transportation was not a factor.

The variable cost of gain included any cost incurred in producing the market animal from the lighter-weight feeder animal. Expenses during this period included feed costs (not including mark-up or margin), yardage fees, direct interest charges on feeder investment, death losses, and all veterinarian and pharmaceutical costs. Feed costs include all grain, hay and mineral/vitamin supplements fed from October 2, 1987 to November 3, 1998. Feedlot ration costs were recorded on a per pen basis and then divided by the number of animals within each pen to determine individual animal ration costs. Hay costs were calculated as the total hay costs delivered per pen divided by the number of animals within each pen. Mineral and salt intake was assumed to be 0.75 g d^{-1} for animals in the backgrounding pens and on pasture. Animals in the feedlot received minerals and salt within the concentrate ration. Pasture rental costs were estimated on a per animal unit month basis (AUM) where an animal unit (AU) was equivalent to one 445 kg cow/calf pair and a yearling steer was equal to 2/3 of an AU (Society of Range Management 1989). Pasture prices were determined using the Alberta Agriculture AgriProfit$ Benchmarks (1999) for the Aspen Parkland area. This price was calculated to included cattle and pasture monitoring by the landowner, and those costs associated with maintenance of pasture facilities (fences, dugouts) including rejuvenation of the forage base. The market

price ($ AUM^{-1}) for tame/native mixed pasture was used as a reasonable representation of the type of forage that the BPF animals were utilizing.

A yardage value was determined based on the Alberta average for feedlot and backgrounding operations (Alberta Feedlot Management Guide 1999) and included utilities, feed and bedding delivery, straw bedding, manure removal, and labour for routine supervision. Yardage was calculated as days on feed (DOF) @ $0.20 per head per day (Alberta Feedlot Management Guide 1999). Animals in the feedlot and backgrounding pens were assigned the same daily yardage value to maintain uniformity in comparisons. Yardage fees were not applied to animals on pasture as this cost was included in the pasture rental price. Yardage was considered a variable cost and not a fixed cost because yardage fees are generated as a direct result of production and would not have to be paid if production stopped.

Interest on the feeder investment was calculated as the sum of the feeder value and half the total feed costs multiplied by the proportion of the year on feed (days on feed/365) and by interest. The interest rate was calculated as the prime lending rate on October 2, 1997 plus 1.5 percentage points. The prime rate is a benchmark rate of interest established by commercial banks and is the rate charged for large loans made to their most credit-worthy business and industrial customers. The prime rate is generally the lowest rate of interest charged by a commercial bank, with other loans calculated as basis points above prime (Agriculture Marketing Manual 1999).

Cost of gain was determined by dividing the total cost of gain for each feeding period (feed, vitamins/minerals/salt, yardage and interest) by the total amount of weight gained in that period. Variable costs for each feeding period were calculated by adding the feeder cost to the cost of gain. Total cost of gain includes all costs of gain for the entire enterprise. Total variable costs for each enterprise assume that the animals were purchased once (Day 1) and therefore include only one feeder value and total cost of gain. Gross margin was calculated as market value minus feeder cost and cost of gain.

3.3 RESULTS AND DISCUSSION

3.3.1 Feed and cattle prices

The feed prices for the experimental period are shown in Table 3.3 and are based on an as-fed basis. Monthly feeder and slaughter prices for 1993-1998 are shown in Table 3.4 and Table 3.5 respectively. Railgrade slaughter prices are also shown in Table 3.6 and only include values averaged over the years of 1996, 1997 and 1998. The reason for this is that in 1996 the Canadian grading system introduced marbling as a criterion and this may have affected the railgrade calculation and consequently the price paid per carcass.

Table 3.3 Per unit base prices used in the economic analysis on an as-fed basis

Item	% of ration	$ tonne^{-1}	$ bushel^{-1}	$ kg^{-1}	value
Rolled Barley[w]	64 %	109.53	2.3848	0.1095	
Rolled Oats[w]	21 %	115.02	1.7739	0.1150	
Alfalfa pellet[y]	10 %	185.00		0.1850	
Premix pellet[y]	5 %	320.00		0.3200	
Ration Total:	**100 %**	**128.77**		**0.1288**	
Brome hay[x]		74.00		0.0740	
Barley straw[x]		26.00		0.0260	
Salt/min/vit suppl.[y]		350.00		0.3500	
Yardage($/hd/d)[z]					0.20
Pasture ($/hd/mo)[z]					12.80
Induction ($/hd)[z]					10.00
Shipping ($/hd)[z]					5.00
Interest (%)[z]					8.00
Commission (%)[z]					3.00
Shrink at slaughter (%)[z]					3.00

[w]6 year composite average for Central Alberta 1993-1998
[x]5 year composite average for Central Alberta 1996-2000
[y]actual purchased price on October 2, 1997
[z]average for Central Alberta 1998
$/hd/day=$ per head per day; $/hd/mo=$ per head per month

Table 3.4 Average monthly feeder cattle prices ($ kg^{-1}) for Central Alberta

Month	136-181 kg	182-226 kg	227-272 kg	273-317 kg	318-362 kg	363-408 kg	408+ kg
Jan	2.7485	2.6645	2.5187	2.3623	2.2366	2.1596	2.0487
Feb	2.8065	2.7508	2.6079	2.4257	2.2614	2.1672	2.0694
Mar	2.8532	2.7551	2.6351	2.4662	2.2811	2.1542	2.0477
Apr	2.8054	2.7385	2.6341	2.4895	2.3031	2.1548	2.0256
May	2.7991	2.7454	2.6528	2.5151	2.3474	2.1814	2.0443
June	2.8483	2.7597	2.6847	2.5554	2.4003	2.2232	2.0611
July	2.8014	2.7186	2.6202	2.4909	2.3576	2.2333	2.1060
Aug	2.8589	2.7589	2.6168	2.4917	2.3893	2.2970	2.1938
Sept	2.8651	2.7482	2.5932	2.4874	2.3873	2.2879	2.1664
Oct	2.8576	2.7287	2.5278	2.4045	2.3171	2.2426	2.1114
Nov	2.8424	2.7362	2.5367	2.3734	2.2816	2.2403	2.1492
Dec	2.8245	2.7142	2.5154	2.3589	2.2693	2.2138	2.1246

Statistics Yearbook. 1993-1998. Alberta Agriculture, Food and Rural Development

Table 3.5 Average monthly slaughter cattle prices ($ kg^{-1}) for Central Alberta

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Liveweight [x]	2.0094	1.9994	2.0276	1.9895	1.9366	1.8714	1.8830	1.9218	1.8853	1.9295	2.0106	1.9554
Railgrade [y]	3.4354	3.4398	3.4741	3.3804	3.2672	3.1398	3.1643	3.2212	3.1914	3.2454	3.4352	3.3671

Statistics Yearbook. 1993-1998. Alberta Agriculture, Food and Rural Development
[x]Paid on a liveweight animal basis
[y]Base price for Canada AA, Yield Grade 2 carcasses on a warm weight basis

3.3.2   Feeder costs

Even though the same initial feeder purchase price (Table 3.6) was assigned to all three treatments, there was a difference of $19 and $10 between the F and BF and F and BPF animals respectively. This difference was due to heavier average weights for the BF and BPF animals.

3.3.3   Cost of gain

The costs of gain required to increase the weight per animal within a specific period is displayed as a cost per feeding period ($ hd^{-1}) and as total cost per enterprise ($ hd^{-1}), a cost per kg gained ($ kg^{-1}) and as a total cost per kg gained in each enterprise ($ kg^{-1}). The cost of gain was low or high depending on whether the feed costs were high or the weight gain low. Interest charges were calculated on a per day basis therefore one day in the feedlot was equally as expensive as a day on pasture. However animals retained for a longer period of time had higher interest costs than those fed for a shorter period.

Of the three treatment groups the lowest cost per kilogram gain of 0.63 $ kg^{-1} occurred during the pasture grazing period of the BPF animals (Table 3.6). This was because although the gains were lower they were also associated with lower feed costs. Animals on pasture do not require the same type of labour, yardage or management fees which normally would be required in drylot. Comparing the pasture period with the subsequent feedlot period shows that the relatively higher daily gains in the feedlot were not high enough to compensate for the more expensive feed costs.

 If the animals had been supplemented on pasture with concentrates for a short period prior to transition into the feedlot, the costs of gain may have been less as the workup period would not have taken as long, and a shorter period with low gains would have occurred. Differences in gut fill between the pasture and feedlot, which may have affected the weights of the animals and subsequent gain calculations are discussed in **CHAPTER TWO**.

Table 3.6 Gross margin analysis for three enterprises – liveweight basis

Item	F Finish Feeders	BF Winter Calves	BF Finish Feeders	BPF Winter Calves	BPF Grazing Feeders	BPF Finish Feeders
VARIABLE COSTS						
Feeder Costs						
Start date	Oct 2	Oct 2	Apr 27	Oct 2	Apr 27	Sept 2
Start wt kg	172	178	319	174	315	437
Induction costs, $ hd^{-1}	10.00	10.00		10.00		
Purchase price $ kg^{-1}	2.8576	2.8576	2.3483	2.8576	2.4351	2.2019
Feeder buy price $ kg^{-1}	488.29	507.10	769.67	498.77	765.45	962.19
A. Total Feeder costs $ hd^{-1}	**498.29**		**517.10**			**508.77**
Cost of gain[x]						
Days on feed	230	207	126	207	128	57
ADG kg/d	1.44	0.61	1.89	0.61	0.96	1.70
Weight gain kg	320	144	197	140	122	71
Feed costs $ hd^{-1}	254.37	109.87	198.17	109.87	51.20	80.80
Salt/min/vit $ hd^{-1}		5.80		5.80	3.58	
Yardage $ hd^{-1}	49.60	41.40	25.10	41.40	-	11.60
Interest $ hd^{-1}	32.97	25.50	27.69	25.12	22.24	16.07
Cost of gain $ kg^{-1}	1.05	1.27	1.27	1.30	0.63	1.52
Total cost of gain$ kg^{-1}	1.05		1.27			1.10
Cost of gain $ hd^{-1}	357.43	182.56	266.74	182.18	77.03	114.87
B. Total cost of gain $ hd^{-1}	**336.94**		**433.52**			**367.69**
C.Total Variable Costs (A+B) $ hd^{-1}	**835.23**		**950.62**			**876.45**
MARKET VALUE-Livewt						
Market date	May 20	Apr 27	Aug 30	Apr 27	Sept 2	Oct 30
Market liveweight kg	491	319	518	315	437	507
Shipping $ hd^{-1}	5.00		5.00			5.00
Commission $ hd^{-1}	27.63		29.05			28.50
Liveweight price $ kg^{-1}	1.9366	2.4133	1.9218	2.4351	2.2019	1.9295
Sale value $ hd^{-1}	921.01	769.67	968.46	765.45	962.19	949.87
D. Total Market Value $ hd^{-1}	**888.37**		**934.40**			**916.37**
GROSS MARGIN – Livewt						
Added value in each phase	53.14	70.00	-52.17	74.50	119.71	- 120.80
E. Total Gross Margin (D-C) $ hd^{-1}	**53.14**		**-16.22**			**39.91**

[x]Cost of gain calculated on an as fed basis
F=finished in feedlot only; BF=backgrounded through winter and then finished in feedlot;
BPF=backgrounded through winter, grazed on pasture and then finished in feedlot.

Gains made during the backgrounding period were also expensive due to the low rate of daily gain on forage. The backgrounding ration was 40% of the cost of the feedlot ration, and less expensive fees for yardage and interest occurred. Even though the input costs of gain for the backgrounded animals were less than those for the feedlot group, the minimal gains during the backgrounding period (60% of the F gains) did not allow for the feed costs to be spread over as many gained kilograms. This is where an equilibrium must be found between the backgrounding costs of gain and the desire to promote future catch up growth. Mathison (1993) and Beacom (1976) showed that as the rate of gain approaches 0.5 kg per day the cost of feed and non-feed inputs became too high to make this feeding rate feasible.

Within the feedlot period the F group had a much lower feed cost per unit of gain than the other two groups: $1.05 compared to $1.27 and $1.55 for F, BF and BPF respectively. The significantly ($P<0.05$) higher average daily gain, due to catch-up growth, during realimentation of the BF and BPF animals (**CHAPTER TWO**) did not help to lower the cost of gain as the intakes of the animals was also much higher than the F group. However the BF and BPF animals were heavier and would be expected to have higher intakes due to a higher maintenance requirement. In the feedlot the BF gained 61% of the F animals gain, however their feed costs were 77% that of the F group.

3.3.4   Total variable costs

The F group had the lowest variable costs followed by the BPF (+$41.22) and then the BF group (+$115.39). The dramatically higher variable costs in the BF group is attributed to the decrease in feed efficiency in the feedlot and the high costs of keeping the animals on feed. The BF animals were fed in an intensive facility for 103 more days than the F animals. The additional yardage and interest costs made the feeding of these animals very inefficient as their costs per day were similar to those of the F group.

3.3.5 Market Value

The trend of the F group having the highest margin followed by the BPF and then BF groups is the same in both the railgrade and liveweight scenarios. Differences between liveweight and railgrade sales indicates that in this analysis the animals sold using the liveweight price method had a higher market value than those sold using railgrade prices

All of the animals in this experiment were within the optimal liveweight range of 250 –385 kg and therefore no discounts for weight were applicable. The highest average liveweight price paid per kg was in May to the F animals followed by the October (BPF) and then September (BF) finished animals. The same trend was also seen in the railgrade base prices where the highest prices were in the spring followed by October and then September. Seasonal variation in prices were expected. Fed cattle prices generally reach their seasonal peaks in late winter and early spring and are lowest during the summer months (Jones et al. 1997).

Shipping fees of $5.00 were standard among all treatment groups and therefore similarly affected the final market value of the three groups. The differences in the calculated commission are reflections of the differences in total market value of the animals. The F animals having the lowest market value and commission while the BPF animals had the highest market value and greatest commission. Even though the F animals were paid using the highest price, they were the lightest and it did not translate into greater returns. The BF animals were the heaviest and showed the highest market value of the three groups.

The premiums and discounts applied to each group show how valuable the carcasses were at that particular point in time (Table 3.7). All three groups saw a composite increase over the railgrade base price, with the BF group benefiting the most and the F group the least. The F animals had the greatest discounts, followed by the BF and then BPF animals. The feedlot only animals were primarily discounted for being too fat while the BPF animals were discounted for not having enough marbling. The BF animals were also discounted for a lack of marbling but not to the same extent as the BPF animals.

Table 3.7 Gross margin analysis for three enterprises –railgrade basis

Item	F Finish Feeders	BF Winter Calves	BF Finish Feeders	BPF Winter Calves	BPF Grazing Feeders	BPF Finish Feeders
VARIABLE COSTS						
Feeder Costs						
Start date	Oct 2	Oct 2	Apr 27	Oct 2	Apr 27	Sept 2
Start wt kg	172	178	319	174	315	437
Induction costs, $ hd⁻¹	10.00	10.00		10.00		
Purchase price $ kg⁻¹	2.8576	2.8576	2.3483	2.8576	2.4351	2.2019
Feeder buy price $ kg⁻¹	488.29	507.10	769.67	498.77	765.45	962.19
A. Total Feeder Costs $ hd⁻¹	**498.29**		**517.10**			**508.77**
Cost of Gain[x]						
Days on feed	230	207	126	207	128	58
ADG kg/d	1.44	0.61	1.89	0.61	0.96	1.70
Weight gain kg	320	142	199	141	122	71
Feed costs $ hd⁻¹	254.37	109.87	198.17	109.87	51.20	80.80
Salt/min/vit $ hd⁻¹		5.80		5.80	3.58	
Yardage $ hd⁻¹	49.60	41.40	25.10	41.40	-	11.60
Interest $ hd⁻¹	32.97	25.50	27.69	25.12	22.24	16.07
Cost of gain $ kg⁻¹	1.05	1.28	1.26	1.30	0.63	1.52
Total cost of gain$ kg⁻¹	1.05		1.27			1.10
Cost of gain $ hd⁻¹	357.43	182.56	266.74	182.18	77.03	114.87
B. Total cost of gain $ hd⁻¹	**336.94**		**433.52**			**367.69**
C.Total Variable Costs (A+B) $ hd⁻¹	**835.23**		**950.62**			**876.45**
MARKET VALUE-Railgrade						
Market date	May 20		Aug 30			Oct 30
Shipping $ hd⁻¹	5.00		5.00			5.00
Commission $ hd⁻¹	27.63		29.05			28.50
Railgrade base price $ kg⁻¹	3.2672		3.2212			3.2454
Premium $ kg⁻¹	0.0872		0.1121			0.0441
Discount $ kg⁻¹	-0.0679		-0.0345			-0.0083
Price adjustment $ kg⁻¹	0.0193		0.0776			0.0358
Railgrade adj. Price $ kg⁻¹	3.2865		3.2988			3.2812
Sale value $ hd⁻¹	879.15		921.31			890.46
D. Total Market Value $ hd⁻¹	**846.52**		**887.26**			**856.96**
GROSS MARGIN – Railgrade						
E. Total Gross Margin (D-C) $ hd⁻¹	**11.29**		**-63.36**			**-19.49**

[x]Cost of gain calculated on an as fed basis
F=finished in feedlot only; BF=backgrounded through winter and then finished in feedlot;
BPF=backgrounded through winter, grazed on pasture and then finished in feedlot.

3.3.6   Gross margin analysis

Gross margin returns were calculated for the value added within each feeding period as well as for the total enterprise. Total liveweight gross margins (Table 3.6) show that the F group had the highest overall margin of $53.14 per head while the BF had the smallest with -$16.22 per head. The BPF group had a gross margin return of $39.91 per head. Even though the F group had the lowest market value, the much greater total feed costs in both backgrounded groups resulted in lower overall margins.

The gross margin value added in each feeding phase shows that the greatest economic increase of $119.71 hd^{-1} was achieved during the pasture grazing period. This was due to the low input costs and cheaper cost of gain during this period. The following finishing phase shows a negative return in this analysis and was -$120.80 because feeder animals are valued higher than slaughter animals due to the potential for profit with a feeder animal. Slaughter prices are typically less per kg than feeder prices and in this study the BPF animals would have received $119.04 less per animal just by being sold using the different price category. The BP group also showed a negative return in the feedlot, however the relatively high feed costs in the feedlot were the reason for the negative value added.

3.3.7 Input sensitivity analysis

From the values in Table 3.7 it is apparent that barley costs are important relative to other inputs but quite small in comparison to the feeder steer investment. Given the costs and market values of the gross margin analysis, the sensitivity of margins to input costs were calculated, using a 10% adjustment to all prices. The results in Table 3.8 indicate that changes to the price of barley have the smallest impact on gross margins followed by feeder and then slaughter (liveweight and railgrade) cattle prices. Although the effects of barley price changes are relatively small in comparison to feeder cattle and finished cattle price changes, potential barley price changes are large enough to warrant consideration. With average gross margins of $ 53.14 per head in the feedlot group, a reduction of $14.15 due to a ten percent increase would have a large total impact within the feeding period and in comparison to the other treatment groups. It must be noted however that in a an average market situation a 10% change in the price of barley would more likely occur than a 10% change in the price of feeder or slaughter animals

As expected, the F animals were more sensitive to a change in barley price than the BF and BPF animals because the F animals had a higher level of barley utilization within the overall feeding program compared to the other two groups. The backgrounded animals were not as sensitive to the price of hay as the feedlot group was to the price of barley. This is because even though the feed costs per kg gain were similar between the backgrounding and F groups, daily dry matter intake was higher in the feedlot compared to the backgrounding period.

All treatment groups were equally sensitive to the price of feeder steers because they were all purchased at the same time using the same price per kilogram. Animals that were retained the longest in drylot (BF) were the most sensitive to changes in yardage price, while those retained and fed for the longest period (BPF) were the most sensitive to interest rate changes. The BPF group showed the same level of sensitivity to changes in the price of yardage and pasture rent. A 10 % change in either commission or shrink had the same influence on each group because both these calculations were based on a 3% difference in liveweight.

Table 3.8 Sensitivity of individual inputs

± 10 % change:	Change in Total Gross Margin per head		
	F	BP	BPF
$ per tonne barley	14.15	10.91	4.41
$ per tonne oats	9.98	7.69	3.31
$ per tonne hay	-	11.24	11.24
$ per kg feeder steers	51.48	54.05	53.73
$ per kg slaughter liveweight	89.34	93.94	92.14
$ per kg railgrade base price	84.66	87.05	85.22
$ per day yardage	4.96	6.65	5.30
$ per month per head pasture rent	-	-	5.19
% interest rate	3.30	5.32	6.34
% commission on sale	2.76	2.91	2.85
% shrink at market	2.76	2.91	2.85

F=feed concentrate diet in feedlot only; BF=backgrounded through winter on forage and finished on concentrate diet in feedlot; BPF=backgrounded through winter on forage, grazed on pasture during summer and finished in feedlot on concentrate diet.

3.3.8 Breakeven analysis

A break-even analyses was used to determine the input price which produced a zero margin within the gross margin analysis. In commercial situations, fixed costs would be included and. Therefore regardless of the breakeven value a negative gross margin would occur if fixed costs were included. Breakeven prices for barley, feeder steers and slaughter cattle are shown in Table 3.9. If fixed costs were included the breakeven points would be different. The analysis shows that when barley is $150.66, $93.25 and $208.58 tonne^{-1} for F, BF and BPF respectively a negative gross margin will occur. Since the BPF group relies the least on barley to achieve total gains, the barley price would have to increase dramatically to produce a negative margin, indicating protection against changes in barley price. In comparison the price of barley would not have to increase as much before it produced a negative margin in the F animals. A breakeven price of $150.66 tonne^{-1} for the F group translates into a 38 % increase in barley price.

Table 3.9 Breakeven prices for gross margin analysis – liveweight basis

Item	F	BF	BPF
Barley $tonne^{-1}	150.66	93.25	208.58
Feeder $kg^{-1}	3.1526	2.7702	3.0763
Slaughter livewt $kg^{-1}	1.8214	1.9550	1.8459

F=finished in feedlot only; BF=backgrounded through winter and then finished in feedlot; BPF=backgrounded through winter, grazed on pasture and then finished in feedlot.

3.3.9   Pricing scenarios

Different pricing scenarios for the price of barley were incorporated into the economic model to determine the gross margin for each enterprise under different market conditions. Barley was increased by 10, 20, 30, 40 and 50 percent per tonne while all other costs remained constant. Gross margins are shown in Table 3.10.

At $124.47 per tonne barley the gross margin of the F group falls below that of the BPF group. It is at this price point that the inclusion of pasture into the feedlot ration increases gross margin. An increase in barley price to $124.47 translate into a 12 % increase, which historically is not an unreasonable degree of fluctuation within a market year (Novak and Viney 1995). Thus the BPF not only shows a resistance to fluctuating barley prices, but it also serves as an alternative feeding program when barley prices increase.

Table 3.10 Effect of increasing barley price on the gross margins of three treatment groups

% increase in barley $/tonne	$ tonne^{-1}	$ bushel^{-1}	F	BF	BPF
10	120.4873	2.6233	38.99	-27.13	35.50
20	131.4407	2.8618	24.83	-38.03	31.09
30	142.3941	3.1002	10.68	-48.94	26.67
40	153.3475	3.3387	-3.47	-59.84	22.26
50	164.3009	3.5772	-17.61	-70.74	17.85

F=finished in feedlot only; BF=backgrounded through winter and then finished in feedlot; BPF=backgrounded through winter, grazed on pasture and then finished in feedlot.

Within the commercial market, barley prices do not change independently of feeder and slaughter prices. Therefore two pricing scenarios representing historical examples of feed and cattle prices when barley market value was low and high were incorporated into the model (Table 3.11). Scenario 1 is an example of low barley, high feeder and low slaughter costs. Scenario 2 is the reverse and involves high barley, low feeder and high slaughter prices. The historical values were corrected using a consumer price index to 1998 values. Tables 3.12, 3.13 and 3.14 show the barley, feeder and slaughter liveweight price used in the gross margin analysis of the two pricing scenarios.

When pricing scenario 1 (low barley, high feeder, low slaughter) was incorporated into the model the result was a negative gross margin for all three enterprises (Table 3.15) with margins of -$164, -$254 and -$210 for F,BF and BPF respectively. Even though the margins in this scenario are negative due to the low slaughter prices, it indicates that when barley prices were this low, the resulting feeder and slaughter prices created a situation where the F animals would have a higher gross margin.

When scenario 2 (high barley, low feeder, high slaughter) was integrated, all three enterprises showed a positive margin, with values of $324, $253 and $336 hd^{-1} for F, BF and BPF respectively. The BPF group had the higher overall gross margin, followed by the F and then BF group. From these two scenarios it can be seen that when barley has a low market value, the F group has a higher gross margin and when barley has a high market value, the BPF group produces the higher gross margin.

Table 3.11 Two pricing scenarios used in the gross margin analysis

Scenario	Barley	Feeder	Slaughter
1 (1993)	low	high	low
2 (1996)	high	low	high

Table 3.12 Barley prices for pricing scenarios 1 and 2

Pricing Scenario	$ kg^{-1}	$ tonne^{-1}	$ bushel^{-1}
1	0.0854	85.44	1.8602
2	0.1150	149.04	3.2449

Scenario 1=high barley, low feeder and high slaughter prices;
Scenario 2=low barley, high feeder and low slaughter prices

Table 3.13 Feeder cattle prices ($ kg^{-1}) for pricing scenarios 1 and 2

Month	136-181 kg	182-226 kg	227-272 kg	273-317 kg	318-362 kg	363-408 kg	408+ kg
Pricing Scenario 1							
April	3.2897	3.1496	2.9945	2.7989	2.5752	2.4298	2.2876
Sept	3.6857	3.5146	3.3066	3.1058	2.9205	2.7514	2.5958
Oct	3.6997	3.5179	3.1997	3.0551	2.8936	2.7214	2.4966
Pricing Scenario 2							
April	1.7659	1.7415	1.7335	1.7121	1.6310	1.5720	1.5249
Sept	1.9262	1.9381	1.9161	1.9225	1.9429	1.9397	1.9055
Oct	1.9295	1.9375	1.8850	1.8751	1.8628	1.9044	1.8716

Scenario 1=high barley, low feeder and high slaughter prices;
Scenario 2=low barley, high feeder and low slaughter prices

Table 3.14 Liveweight slaughter cattle prices ($ kg^{-1}) for pricing scenarios 1 and 2

Pricing Scenario	May	Aug	Sept
1	1.6447	1.8527	1.9582
2	1.7266	1.7118	1.7195

Scenario 1=high barley, low feeder and high slaughter prices;
Scenario 2=low barley, high feeder and low slaughter prices

Table 3.15 Gross margin analysis for pricing scenario 1 – liveweight basis

Item	F	BF		BPF		
	Finish Feeders	Winter Calves	Finish Feeders	Winter Calves	Grazing Feeders	Finish Feeders
VARIABLE COSTS						
Feeder Costs						
Start date	Oct 2	Oct 2	Apr 27	Oct 2	Apr 27	Sept 2
Start wt kg	172	178	319	174	315	437
Induction costs, $ hd^{-1}	10.00	10.00		10.00		
Purchase price $ kg^{-1}	2.8576	2.8576	2.3483	2.8576	2.4351	2.2019
Feeder buy price $ kg^{-1}	488.29	507.10	769.67	498.77	765.45	962.19
A. Total Feeder Costs $ hd^{-1}	**498.29**		**517.10**			**508.77**
Cost of Gain^x						
Days on feed	230	207	126	207	128	57
ADG kg/d	1.44	0.61	1.89	0.61	0.96	1.70
Weight gain kg	320	142	199	141	122	71
Feed costs $ hd^{-1}	224.01	109.87	174.51	109.87	51.20	71.16
Salt/min/vit $ hd^{-1}		5.80		5.80	3.58	
Yardage $ hd^{-1}	49.60	41.40	25.10	41.40	-	11.60
Interest $ hd^{-1}	40.02	32.28	30.41	31.79	24.87	19.10
Cost of gain $ kg^{-1}	0.98	1.33	1.16	1.35	0.65	1.43
Total cost of gain$ kg^{-1}	0.98		1.23			1.11
Cost of gain $ hd^{-1}	313.63	189.34	230.03	188.85	79.66	101.86
B. Total cost of gain $ hd^{-1}	**313.63**		**419.37**			**370.37**
C.Total Variable Costs (A+B) $ hd^{-1}	**835.23**		**950.62**			**876.45**
MARKET VALUE-Livewt						
Market date	May 20	Apr 27	Aug 30	Apr 27	Sept 2	Oct 30
Market liveweight kg	491	319	518	315	437	507
Shipping $ hd^{-1}	5.00		5.00			5.00
Commission $ hd^{-1}	24.63		25.88			25.39
Liveweight price $ kg^{-1}	1.7266	2.7111	1.7118	2.7337	2.6412	1.7195
Sale value $ hd^{-1}	821.13	864.52	862.63	859.15	1,154.06	846.49
D. Total Market Value $ hd^{-1}	**791.50**	**864.52**	**831.75**	**859.15**	**1,154.06**	**816.09**
GROSS MARGIN – Livewt						
Added value in each phase	- 164.31	8.64 -	231.92	14.55	215.25	- 409.43
E. Total Gross Margin (D-C) $ hd^{-1}	**- 164.31**		**- 254.16**			**- 210.03**

^{x}Cost of gain calculated on an as fed basis
F=finished in feedlot only; BF=backgrounded through winter and then finished in feedlot;
BPF=backgrounded through winter, grazed on pasture and then finished in feedlot.

Table 3.16 Gross margin analysis for pricing scenario 2 – liveweight basis

Item	F Finish Feeders	BF Winter Calves	BF Finish Feeders	BPF Winter Calves	BPF Grazing Feeders	BPF Finish Feeders
VARIABLE COSTS						
Feeder Costs						
Start date	Oct 2	Oct 2	Apr 27	Oct 2	Apr 27	Sept 2
Start wt kg	172	178	319	174	315	437
Induction costs, $ hd⁻¹	10.00	10.00		10.00		
Purchase price $ kg⁻¹	2.8576	2.8576	2.3483	2.8576	2.4351	2.2019
Feeder buy price $ kg⁻¹	488.29	507.10	769.67	498.77	765.45	962.19
A. Total Feeder Costs $ hd⁻¹	**498.29**		**517.10**			**508.77**
Cost of Gain^x						
Days on feed	230	207	126	207	128	57
ADG kg/d	1.44	0.61	1.89	0.61	0.96	1.70
Weight gain kg	320	142	199	141	122	71
Feed costs $ hd⁻¹	304.16	109.87	236.96	109.87	51.20	96.62
Salt/min/vit $ hd⁻¹		5.80		5.80	3.58	
Yardage $ hd⁻¹	49.60	41.40	25.10	41.40	-	11.60
Interest $ hd⁻¹	25.60	18.03	20.70	17.77	15.67	14.20
Cost of gain $ kg⁻¹	1.19	1.22	1.43	1.25	0.58	1.72
Total cost of gain $ kg⁻¹	1.19		1.34			1.10
Cost of gain $ hd⁻¹	379.37	175.09	282.76	174.83	70.45	122.42
B. Total cost of gain $ hd⁻¹	**379.37**		**457.85**			**367.71**
C.Total Variable Costs (A+B) $ hd⁻¹	**719.07**		**810.25**			**714.48**
MARKET VALUE-Livewt						
Market date	May 20	Apr 27	Aug 30	Apr 27	Sept 2	Oct 30
Market liveweight kg	491	319	518	315	437	507
Shipping $ hd⁻¹	5.00		5.00			5.00
Commission $ hd⁻¹	32.41		33.02			32.64
Liveweight price $ kg⁻¹	2.2715	1.6777	2.1844	1.6885	1.9155	2.2104
Sale value $ hd⁻¹	1,080.27	536.03	1,100.81	531.17	837.74	1,088.12
D. Total Market Value $ hd⁻¹	**1,042.87**		**1,062.78**			**1,050.48**
GROSS MARGIN – Livewt						
Added value in each phase	323.80	8.54	282.02	9.56	236.11	127.97
E. Total Gross Margin (D-C) $ hd⁻¹	**323.80**		**252.53**			**336.00**

^{x}Cost of gain calculated on an as fed basis
F=finished in feedlot only; BF=backgrounded through winter and then finished in feedlot;
BPF=backgrounded through winter, grazed on pasture and then finished in feedlot.

3.4 Conclusion

Using average feed and cattle prices for the last six years it was shown that the F animals had the highest gross margin, followed by the BPF animals. Analysis of the BF enterprise shows a 130 % lower gross margin than the F group. Of the three main price factors affecting economic viability (barley, feeder price, slaughter price), slaughter price was the most influential on margin over inputs, while barley had the least impact. The F enterprise was four times as sensitive to changes in barley price compared to the other two groups due to its reliance on barley as the main feed source within the ration. Barley would have to increase by 37 % to \$139 tonne^{-1} (\$3.04 bushel^{-1}) in order for the F group to hit its breakeven point.

The pasture grazing period produced a positive margin irrespective of changing barley, feeder and slaughter price. Inexpensive gains on pasture were due to low feed costs and high gains from catch-up growth. Pasture rental price would have to increase by 600 % to \$80.00 per head before the breakeven point is met.

Total variable costs were different between enterprises. The costs of retaining the BF in drylot for the extra period necessary for finishing was not compensated by the greater daily gains in the feedlot.

When the market value of barley is low, concentrate feeding of calves produces the highest gross margin, however when the market value of barley is high, Considerable increases in gross margin were realized by including pasture within the wean to finish period

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CHAPTER FOUR

General Discussion and Conclusions

4.1 General discussion and conclusions

The objective of this study was to determine if backgrounding followed by either an extensive pasture finishing or feedlot finishing period was a viable alternate to intensive, high-energy grain feedlot finishing. The results indicate that backgrounding followed by feedlot finishing was not viable, while backgrounding followed by pasture grazing and then a short feedlot period was.

Medium framed crossbred beef cattle finished as calves, were very efficient and made relatively economical gains because of high daily gains and low interest and yardage costs. Cattle grown on forages prior to finishing required more days from weaning to market and, therefore, more interest costs accrued. These costs were offset during the pasture grazing period as it involved a low cost forage (pasture rent) and no yardage fees. The animals fed in the feedlot following backgrounding were not as economical as the feedlot only animals due to the extra 100 days in drylot with accumulating yardage fees and high feed costs. The compensatory growth following backgrounding increased average daily gain but was associated with decreased feed efficiency, which resulted in increased feed costs.

Gross margin analysis of the data, showed that when barley had a low market value of $110 per tonne the F group had the highest gross margin. However when barley price was increased by 15% to $126 per tonne the BPF group had a higher gross margin. By implementing backgrounding and pasture into the wean to finish program a resistance to fluctuating barley price occurred.

The possibility of marketing cattle as a group directly off pasture did not exist as they were unable to reach an acceptable level of finish on pasture due to the low level of dietary energy within the forage. Over 30% were under the minimum 4 mm subcutaneous backfat thickness required for Canada A grades. In addition it is doubtful that the majority of animals would have had the trace level of marbling required and would have graded B1. The normal reduction in quantity and quality in

late summer limited the rate of liveweight gain in the late grazing season and slowed the rate of fattening necessary for finish.

Cattle can be finished on pasture as shown by McCaughey and Clipleff (1996) who successfully finished 69% of animals directly off pasture after 160 days on alfalfa/brome/wildrye pastures. However they did observe that a finishing period of 33 or 72 days resulted in increased return over those marketed directly off pasture and suggested that to reduce the risks of carcasses being discounted for lack of finish a short grain-feeding period appears necessary.

In the current study all animals (except one BF "poor doer") met minimum Canada A grade standards. Treatment did not have an effect on final weight, warm carcass weight, or rib-eye area. However it did affect estimated cutability, yield grade and quality grade. While the BPF animals had the highest cutability and yield grades due to a greater lean depot, they did not have the same level of finish as the other two groups. The F group was the fattest at finish yet they did not have the highest percentage of AAA animals indicating that the high level of fat deposited in the feedlot period did not necessarily translate into high levels of marbling. This would be expected since marbling is an age related depot (Berg and Butterfield 1976). Animals finished exclusively in the feedlot also had the lowest yield grade and cutability estimates due to excess backfat.

4.2 Implications

The beef cattle industry is the single largest source of farm cash receipts in Alberta (Agriculture Statistics Yearbook 1999). Beef cattle receipts were 2.1 billion dollars in 1999 and were 47 percent of total farm receipts. The feeding and finishing of beef cattle in feedlots in Alberta is a big part of the beef cattle industry in Alberta.

Feedlots are coming under close public scrutiny. Two of the largest concerns are (i) animal waste with its potential impact on water quality and (ii) concern over feeding large amounts of grain to fatten cattle rather than direct consumption by the human population (Grienbenow et al. 1997). Another major challenge to the feedlot industry is their strong reliance on barley and their serious economic vulnerability to high and fluctuating grain prices (Novak and Viney 1995). The beef industry has to

seriously consider alternative, feasible production systems for finishing beef (Grienbenow et al. 1997). Options to the extensive finishing of all incoming cattle on high concentrate diets do exist, such as backgrounding and pasture finishing.

Backgrounding has existed for some time, and was traditionally integrated with the feedlot enterprise, which handled calves from weaning until they were sold for slaughter. However to increase the number of animals a feedlot finishes (turnover) and decrease costs, their portion of the finishing process is being narrowed to the final 136 kg of weight gain (Karanumms et al. 1997). The beef finishing system is restructuring with specialized operations being created that focus solely on backgrounding cattle.

In this study backgrounding was not found to be a viable alternative to the intensive finishing of weaned calves in the feedlot. Reasons for this may be due to differences in the type of rations used and days on feed, between this study and backgrounding lots and better economies of scale afforded to large scale operations.

Even though animals were unable to finish on pasture the incorporation of pasture after a backgrounding period could be a viable alternative when barley prices have a higher market value. Grazing on pasture may not be suitable for large scale feedlots but it could apply to smaller scale producers with available pastures.

The future of the feedlot industry points towards value based marketing (McCaughey et al. 2000). If the consumer desire continues for organic food produced in an environmentally friendly method, the potential premiums attached to grass fed beef may warrant its introduction into some area of the feeding industry. Also if the benefits of omega three fatty acids in forage fed beef can be shown to be favorable it may also increase the demand for forage finished beef (Mandell et al. 1998). Using a backgrounding/pasture program would be one way to increase forage intake and finish on grass alone.

Not all cattle will perform equally on forage and it is important to match the breed type to the finishing program. Predominate British type breeds would be the breed choice in backgrounding and pasture grazing programs for optimal performance and economic results.

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APPENDICES

Appendix 1. Body Condition Scoring System Commonly used in Canada

Score	Condition	Characteristics
1	Too thin. Cow is close to death	**Emaciated.** Extremely emaciated with not palpable fat over the short ribs or hip bones. Backbone, ribs and hips are prominent.
2	Too thin.	**Thin.** The short ribs can be identified individually but are rounder rather than sharp. There is some fatty tissue over tailhead, hips and ribs.
2.5	Acceptable for mature cows at calving and all cows at breeding	**Low moderate**. Individual ribs are no longer visually prominent. The short ribs can only be felt with firm pressure but are rounded rather than sharp. Some fat is present over the ribs and hip bones. Limited fat around the tailhead.
3	Desirable for heifers at all times and for cows in the fall.	**Moderate**. Cow generally has good Overall appearance. Fat cover over ribs feels spongy and there is fat cover on either side of the tailhead.
3.5	Acceptable for all cows	**High moderate**. Firm pressure is required to feel the spinal processes. Lots of palpable fat over ribs and around tailhead.
4	Excessive condition. Feeding costs will be high	**Excessive Condition.** Cow appears fleshy and to carry considerable fat. Very spongy fat cover over ribs and around tailhead. Some fat around vulva and in the crotch.
5	Too fat. Longevity will be reduced	**Fat.** Fat around tailhead is seen and is soft to the touch. Very smooth backbone. The short ribs cannot be felt and folds of fat are beginning to form around the ribs and thighs. Lumps of fat are becoming obvious.

Mathison, G. W. 1993. The Beef Industry. Pages 49 *in* Martin, J., Hudson, R. J. and Young, B. A. ed. Animal Production in Canada. University of Alberta, Edmonton.

Appendix 2. The Canadian beef grading system

Grade	Maturity Level	Muscling	Cutability estimate	Marbling level	Rib-eye colour	Grade fat level	Fat colour, texture & distribution	Short cut grade
A	Youthful	Good to excellent	49-64 %	Traces	Bright red	≥ 4 mm	Firm, white to amber	youthful animal with no deficiencies
AA	"	"	"	Slight	"	"	"	"
AAA	"	"	"	≥Small	"	"	"	"
Prime	"	"	"	Slightly abundant	"	"	"	"
B1	"	"		Devoid all levels	"	> 0	"	Youthful animal devoid of marbling or deficient in grade fat
B2	"	Deficient to excellent			"	0< 4	Yellow	Youthful animal with yellow fat
B3	"	Deficient to good			"		Firm, white to amber	Youthful animal with deficient muscling
B4	"	Deficieint to excellent			Dark red		White to yellow	Youthful animal that is dark cutting
D1	Mature	Excellent				< 15 mm	Firm, white to amber, fat extends well over ribs & loins & moderately well over hips & chucks	Cow with no deficiencies
D2	"	Medium to excellent				"	Firm to slighly soft, white to yellow, fat extends moderately well over the ribs & loins & lightly over hips & chucks	Cow with medium muscling or yellow fat
D3	"	Deficient (emaciate)				"		Emaciated cow
D4	"	Deficient to excellent				≥ 15 mm		Over-fat cow
E	Youthful or mature	Bull or stag, Pronounced masculinity						Bulls

Anonymous. 1996. Beef Carcass Grading Regulations. Canada Gazette Part III. 126, 473.